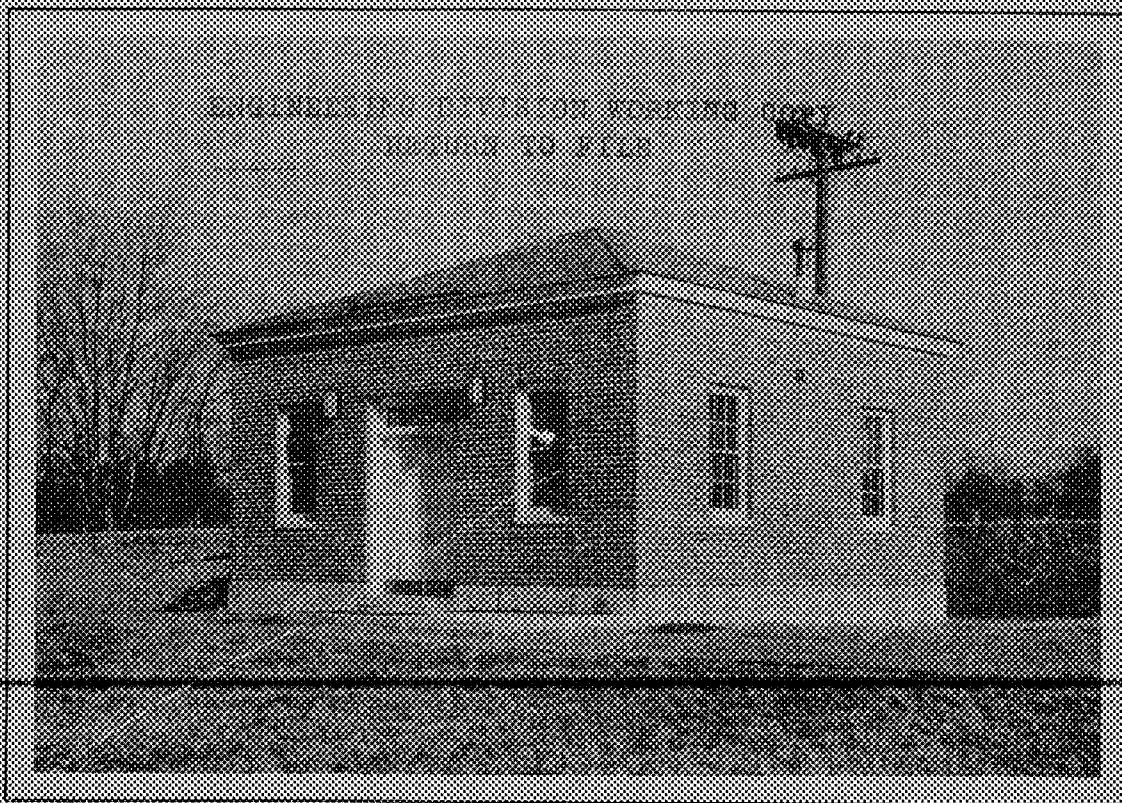


MERRIMACK RIVER FLOOD CONTROL  
**OPERATION AND MAINTENANCE  
MANUAL**  
FOR  
FLOOD PROTECTIVE WORKS  
**NASHUA, NEW HAMPSHIRE**



CORPS OF ENGINEERS, U. S. ARMY  
OFFICE OF THE DIVISION ENGINEER  
NEW ENGLAND DIVISION, BOSTON, MASSACHUSETTS  
MARCH 1950

OPERATIONS AND MAINTENANCE MANUAL

FLOOD PROTECTIVE WORKS

AT

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## FLOOD PROTECTIVE WORKS

NASHUA, NEW HAMPSHIRE

### FOREWORD

The successful functioning of a flood protection system is not assured by construction of an adequate system of dikes, walls and pumping plants. If the system is to perform its function it must be carefully maintained during periods of normal river stages and properly operated during flood periods.

The need for proper maintenance cannot be too highly stressed in view of the fact that large damages may be incurred through failure of a critical element in flood time, caused by deterioration or damage that would have been eliminated by proper maintenance.

Necessary maintenance and proper operation require that responsible local persons have a thorough understanding of the functions of the various units of the system and the best methods of maintaining the system and operating it during flood emergencies. It is the purpose of this manual to provide complete information so that all parties may know their responsibilities in maintaining and operating the flood protection system in accordance with the regulations prescribed by the Secretary of War so as to obtain maximum benefits. Maintenance and operation shall be provided in strict accordance with the regulations prescribed by the Secretary of War as amplified by this manual.

# OPERATION AND MAINTENANCE MANUAL

## FLOOD PROTECTIVE WORKS

### NASHUA, NEW HAMPSHIRE

#### TABLE OF CONTENTS

<u>Paragraph No.</u>	<u>Title</u>	<u>Page No.</u>
<u>SECTION I. GENERAL</u>		
1-01	Introduction	1
1-02	Authorization	1
1-03	Location	1
1-04	Dates of Construction	1
1-05	Location Map	1
<u>SECTION II. LOCAL COOPERATION REQUIRED</u>		
2-01	Flood Control Acts	2
2-02	Assurances	2
<u>SECTION III. GENERAL REGULATIONS</u>		
3-01	Purpose of this Manual	3
3-02	General Rules and Regulations	3
3-03	Maintenance	5
3-04	Operation	5
3-05	Reports	6
<u>SECTION IV. DIKES</u>		
4-01	Description	7
4-02	Maintenance	7
4-03	Operation	9
4-04	Emergency Repair Methods	10
<u>SECTION V. FLOOD WALL</u>		
5-01	Description	14
5-02	Maintenance	14
5-03	Operation	15
5-04	Emergency Repair Methods	15
<u>SECTION VI. PUMPING STATION</u>		
6-01	Description	16
6-02	Maintenance	18
6-03	Operation	20

TABLE OF CONTENTS (Cont.)

<u>Paragraph No.</u>	<u>Title</u>	<u>Page No.</u>
<u>SECTION VII. OPENINGS THROUGH PROTECTION</u>		
<u>SYSTEM</u>		
7-01	Description	23
7-02	Maintenance	23
7-03	Operation	24
<u>SECTION VIII. DRAWINGS</u>		
8-01	Drawings	25

A P P E N D I C E S

APPENDIX "A"

REGULATIONS PRESCRIBED BY THE SECRETARY OF WAR

APPENDIX "B"

ASSURANCES OF LOCAL COOPERATION

APPENDIX "C"

INSPECTION REPORTS

APPENDIX "D"

DRAWINGS

## SECTION I

### GENERAL

1-01. Introduction. - The Nashua Dike protects an area of 70 acres in the City of Nashua, New Hampshire, which is occupied by industrial establishments and residences. The area was flooded to depths ranging from 10 to 17 feet in 1936 and 5 to 8 feet in 1938. The elevation of the top of the dikes (El. 122.0 m.s.l.) was selected to protect the area against the 1936 flood modified by the Franklin Falls and Blackwater Reservoirs.

1-02. Authorization. - The project for local flood protection at Nashua, New Hampshire, was authorized by the Flood Control Acts approved 22 June 1936 and 28 June 1938.

1-03. Location. - The Nashua Local Protection Project is located on the right banks of the Nashua and Merrimack Rivers at their confluence in the City of Nashua, New Hampshire, 55 miles above the mouth of the Merrimack River.

1-04. Dates of Construction. - The work was constructed between 1 July 1946 and 16 November 1948.

1-05. Location Map. - The location of the project is shown on Plate VI of Appendix "D".

## SECTION II

### LOCAL COOPERATION REQUIREMENTS

2-01. Flood Control Acts. - The Flood Control Act approved June 22, 1936 (Public No. 738, 74th Congress) provides, "That hereafter, no money appropriated under authority of this Act shall be expended on the construction of any project until States, political subdivisions thereof, or other responsible local agency have given assurances satisfactory to the Secretary of War that they will:

"(a) Provide without cost to the United States all lands, easements and rights-of-way necessary for the construction of the project;

(b) Hold and save the United States free from damages due to the construction works, and

(c) Maintain and operate all the works after completion in accordance with regulations prescribed by the Secretary of War".

The Flood Control Act approved June 28, 1938 (Public Law No. 761, 75th Congress) which provided authorization for the flood protection work at Nashua, New Hampshire stated that the above provisions (a), (b) and (c) would still apply.

2-02. Assurances. - Assurances were furnished the Secretary of War by the City of Nashua on June 16, 1944 and on March 27, 1946.

A copy of these assurances is given in Appendix "B" of this manual.

### SECTION III

#### GENERAL REGULATIONS

3-01. Purpose of the Manual. - The purpose of this manual is to present detailed information to supplement the "Flood Control Regulations - Maintenance and Operation of Flood Control Works" as approved by the Acting Secretary of War on 9 August 1944, and published in the Federal Register on 17 August 1944. A copy of the Regulations is included in this volume as Appendix "A".

3-02. General Rules and Regulations. - The general rules of the regulations prescribed by the Secretary of War to govern the maintenance and operation of flood control works are given in quotation marks in the following paragraphs and are defined further by remarks under each quotation. Attention is invited to the fact that where reference is made to the District Engineer in the published Regulations, the Division Engineer should be substituted therefor.

"(1) The structures and facilities constructed by the United States for local flood protection shall be continuously maintained in such a manner and operated at such times and for such periods as may be necessary to obtain the maximum benefits."

(a) The city authorities shall make adequate provisions for funds, personnel, equipment, and materials for the proper maintenance and operation of the flood protection works.

"(2) The State, political subdivision thereof, or other responsible local agency, which furnished assurance that it will maintain and operate flood control works in accordance with regulations prescribed by the Secretary of War, as required by law, shall appoint a permanent committee consisting of or headed by an official hereinafter called the "Superintendent" who shall be responsible for the development and maintenance of, and directly in charge of, an organization responsible for the efficient operation and maintenance of all structures and facilities during flood periods and for continuous inspection and maintenance of the project works during periods of low water, all without cost to the United States."

(a) The members of the committee should preferably be experienced in work of a nature similar to the flood protection works. The committee must be given sufficient authority to carry out its duties.

"(3) A reserve supply of materials needed during a flood emergency shall be kept on hand at all times."

(a) Adequate stocks of materials such as sandbags, canvas or sisal-craft paper, picks, shovels, block and tackle, crow bars, etc., shall be obtained and stored. Sources of additional supplies of material, tools and equipment should be established in order that these articles may be obtained quickly in case of an emergency.

"(4) No encroachment or trespass which will adversely affect the efficient operation or maintenance of the project works shall be permitted upon the rights-of-way for the protective facilities."

(a) The grazing of cattle, disposal of rubbish, erection of fences or barriers, wearing of foot paths or any form of trespassing on the project shall be prohibited.

"(5) No improvement shall be passed over, under, or through the walls, levees, improved channels or flood ways, nor shall any excavation or construction be permitted within the limits of the project right-of-way, nor shall any change be made in any feature of the works without prior determination by the District Engineer of the War Department or his authorized representative that such improvement, excavation, or alteration will not adversely affect the functioning of the protective facilities. Such improvements or alterations as may be found to be desirable and permissible under the determination shall be constructed in accordance with standard engineering practice. Advice regarding the effect of proposed improvements or alterations on the functioning of the project and information concerning methods of construction acceptable under standard engineering practice shall be obtained from the District Engineer, or, if otherwise obtained, shall be submitted for his approval. Drawings or prints showing such improvements or alterations as finally constructed shall be furnished the District Engineer after completion of the work."

(a) Any contemplated improvements or alterations as outlined above shall be submitted to the Division Engineer, New England Division, Corps of Engineers, Army Base, Boston 10, Mass., and the approval of the Division Engineer obtained prior to the town authorizing the work. All requests for approval shall be in writing and complete drawings in duplicate, one set of which shall be in reproducible form, must be submitted along with a full description of the work intended. The City will be held responsible for obtaining prior approval from the Corps of Engineers of any improvements or alterations proposed by themselves, private parties or any public utilities. The City shall furnish the Division Engineer as-built drawings of the completed work in duplicate.

"(6) It shall be the duty of the superintendent to submit a semi-annual report to the District Engineer covering inspection, maintenance, and operation of the protective works."

(a) Instructions on submitting reports are given in Paragraph 3-05.

"(7) The District Engineer or his authorized representatives shall have access at all times to all portions of the protective works."

(a) The Division Engineer or his representatives will make periodic inspections of the protective works.

"(8) Maintenance measures or repairs which the District Engineer deems necessary shall be promptly taken or made."

"(9) Appropriate measures shall be taken by local authorities to insure that the activities of all local organizations operating public or private facilities connected with the protective works are coordinated with those of the superintendent's organization during flood periods."

(a) The City should formulate plans and negotiate agreements with local organizations operating facilities connected with the protection works to insure that their activities will be properly coordinated with the superintendent's organization during flood periods.

"(10) The War Department will furnish local interests with an Operation and Maintenance Manual for each completed project, or separate useful part thereof, to assist them in carrying out their obligations under these regulations."

(a) The City authorities are encouraged to call on the U. S. Division Engineer Office for additional advice and instructions to aid in maintaining and operating the flood protection facilities.

3-03. Maintenance. - The dike and pumping station shall be maintained in excellent condition. Inspections of the facilities shall be made at intervals not exceeding 90 days, immediately following floods, and immediately prior to flood seasons. Inspection of the dike shall be made on foot, and all features should be examined. The pumping station shall be test operated periodically. Repair work and upkeep shall be performed promptly. Details of maintenance for the major features are discussed in following sections of the manual.

3-04. Operation. - The flood protection works shall be operated in periods of flood stage in accordance with the provisions of this manual. It is essential that at least one person be familiar with all features of the work and the steps required in the operation of the system, and with sources of personnel, materials, tools, and transportation for patrolling and emergency work in case of flood. Arrangements shall be

with the United States Weather Bureau, Concord, New Hampshire (telephone Concord 3470), to keep the City informed on flood predictions. The Weather Bureau Office at Concord is the official agency for collecting precipitation and runoff data and the preparation of flood forecasts and is responsible for issuance of flood warnings based on telephoned reports of precipitation and runoff received every six hours from selected points in the Merrimack River Basin. From these data Merrimack River stage forecasts for critical locations between Franklin, N. H. and Lowell, Mass., are prepared.

3-05. Reports. - The regulations prescribed by the Secretary of War prescribe the submission of reports to the Division Engineer covering inspection, maintenance, and operation. Semi-annual reports shall be submitted in triplicate each February and August. The reports will be submitted in letter form and should include copies of the inspection forms covering the inspections made during the period. Samples of these reports are given in Appendix "C" for the use of the superintendent in printing additional copies. The reports shall include the following information:

- a. Description of maintenance work.
- b. Number and classification of men working on maintenance, regularly and intermittently.
- c. Description of work performed by contract for the repair or improvement of the system.
- d. Use or operation of the system during the period.
- e. Suggestions.

## SECTION IV

### DIKES

4-01. Description. - The protective structures, shown on Plates VII and VIII, Appendix "D" consist of approximately 3100 linear feet of dike and approximately 230 feet of concrete wall. The dike is constructed of rolled fill earth with a seeded topsoil covering. Where the river velocities are high, hand placed riprap is provided on the river-side slope of the dike in place of topsoil. Details of the dike cross section are shown on Plate IX, Appendix "D".

4-02. Maintenance. - a. The regulations prescribed by the Secretary of War under Paragraph 208.10 (b) (1) give rules for the maintenance of levees. These rules apply to earth dikes, and are quoted here to avoid cross references to the regulations. Following this, a few of the points that apply particularly to the city of Nashua are discussed.

"Levees - (1) Maintenance. The Superintendent shall provide at all times such maintenance as may be required to insure serviceability of the structures in time of flood. Measures shall be taken to promote the growth of sod, exterminate burrowing animals, and to provide for routine mowing of the grass and weeds, removal of wild growth and drift deposits, and repair of damages caused by erosion or other forces. Where practicable, measures shall be taken to retard bank erosion by planting of willows or other suitable growth on areas riverward of the levees. Periodic inspections shall be made by the Superintendent to insure that the above maintenance measures are being effectively carried out and, further, to be certain that:

"(i) No unusual settlement, sloughing or material loss of grade or levee cross section has taken place;

"(ii) No caving has occurred on either the land side or the river side of the levee which might affect the stability of the levee section;

"(iii) No seepage, saturated areas, or sand boils are occurring;

"(iv) Toe drainage systems and pressure relief wells are in good working condition, and that such facilities are not becoming clogged;

"(v) Drains through the levees and gates on said drains are in good working condition;

"(vi) No revetment work or riprap has been displaced, washed out or removed;

"(vii) No action is being taken, such as burning grass and weeds during inappropriate seasons, which will retard or destroy the growth of sod;

"(viii) Access roads to and on the levee are being properly maintained;

"(ix) Cattle guards and gates are in good condition;

"(x) Crown of levee is shaped so as to drain readily, and roadway thereon, if any, is well shaped and maintained;

"(xi) There is no unauthorized grazing or vehicular traffic on the levees;

"(xii) Encroachments are not being made on the levee right-of-way which might endanger the structure or hinder its proper and efficient functioning during times of emergency.

"Such inspections shall be made immediately prior to the beginning of the flood season; immediately following each major high water period, and otherwise at intervals not exceeding 90 days; and such intermediate times as may be necessary to insure the best possible care of the levee. Immediate steps will be taken to correct dangerous conditions disclosed by such inspections. Regular maintenance repair measures shall be accomplished during the appropriate season as scheduled by the Superintendent."

b. Any unusual settlement, sloughing or caving shall be corrected ~~To~~ restore the original dike grades. No major repair work shall be made without prior approval of the Division Engineer.

c. The grassed slopes shall be cut regularly to promote good turf. The grass should be cut back to about 4 inches when it reaches a height of about 8 inches.

d. Reseeding operations, when required, should be started at the earliest practicable date in the spring. Areas to be seeded shall first be dressed to grade and all washes filled. The surface shall then be raked or harrowed parallel to the contour of the dike to a depth of  $3/4$  of an inch. After seeding the surface shall be lightly raked and rolled. The proper seed mixture and amounts of lime and fertilizer shall be established by consulting the University of New Hampshire or a recognized agronomist.

4-03. Operation. - a. The regulations prescribed by the Secretary of War under Paragraph 208.10 (b) (2) give rules for the operation of levees. These rules apply to earth dikes and are quoted here to avoid cross reference to the regulations.

"Levees - (2) Operation. During flood periods the levee shall be patrolled continuously to locate possible sand boils or unusual wetness of the landward slope and to be certain that:

"(i) There are no indications of slides or sloughs developing;

"(ii) Wave wash or scouring action is not occurring;

"(iii) No low reaches of levee exist which may be overtopped;

"(iv) No other conditions exist which might endanger the structure.

"Appropriate advance measures will be taken to insure the availability of adequate labor and materials to meet all contingencies. Immediate steps will be taken to control any condition which endangers the levee and to repair the damaged section."

b. The dike system will be operated under flood conditions ranging from a moderate spring freshet to a major flood. As there is no time to make extensive preparations, prompt action upon receipt of flood warning is of the utmost importance.

(1) Patrolmen shall be assigned to inspect the dikes. On each inspection trip the dike shall be examined for evidence of seepage or wetness on the landside slope, boils on the landside of the dike, wave wash or scouring on the riverside slope, and indications of slides or sloughs on both slopes.

(2) Trespass on the dike shall be prohibited.

(3) Plans shall be available for bringing in material by trucks. One-way traffic on the top of the dike is advisable. Two-way traffic is permissible in case of necessity and the trucks may be driven down the landside slope of the dike after loading.

(4) Patrolling of the dike will commence on receipt of flood warning. After a river stage of 28 on the staff gage on the Taylor Falls Bridge (El 115.2 m.s.l.) is reached a thorough examination shall be made at intervals of not more than 4 hours. As the water rises the

interval between examinations shall be shortened. At major flood stages the dikes shall be examined at hourly intervals and special watchmen shall be assigned at critical points.

(5) When the river stage approaches 31.7 (El. 119.0) the railroad openings at Stations 0 + 00 and 38.60 shall be sandbagged to El. 122.0. The sandbag barricades will require constant inspection to detect leakage or possibility of failure.

4-04. Emergency Repair Methods. - a. Scours. - Careful watch shall be maintained over stretches of the dike where scouring is likely to occur, such as slopes not protected by riprap and angles in the dike alignment subject to strong current. If indication of scouring is observed, soundings should be taken to observe the amount and progress of the scour. The use of sandbags or dumped rock will generally prove a practicable means of preventing further scour. Open ends of sandbags must be sewed or tied after filling with the earth.

b. Wave Wash. - Dikes may be subjected to wave wash on broad reaches of water even though the direct action of high wind is impeded by natural barriers such as trees. Well sodded slopes will usually withstand waves from a storm of about an hour's duration without serious damage. An attack over a longer period may become serious and the slopes should be protected by sacking or equivalent protection. Extent of washes can be observed by wading along the attacked slope. Sandbags shall be placed in the eroded area and the protection should be extended well above the action of the waves. Sandbags used for this purpose require only about one-half cubic foot of material and shall be sewed or tied. The aim is to obtain a maximum of coverage with only sufficient weight to hold the sack in place.

as to progress or seepage up the back slope and the amount of material that is being carried by the water. If the seep velocity becomes great enough to cause, or probably cause, erosion or sloughing of the slope, a sandbag covering shall be placed on the seeping area, beginning well out from the toe and progressing up the slope. The covering shall extend several feet beyond the saturated area. If the material is obtainable, the affected area shall be covered with brush, straw or similar permeable material to a depth of two or four inches before placing the sandbag cover. This will permit the seep water to get away while serving as a filter to prevent loss of earth from the dike. After the covering is placed, close observation shall be maintained and additional layers of sandbags placed on the previous one until the velocity of the seepage is reduced to a point at which the amount of material carried is negligible.

e. Raising existing earth dikes. - In an emergency, time and other conditions permitting, the grade of a dike can be safely raised at least three feet. The method most commonly used for this purpose is outlined in the following paragraphs and illustrated by exhibits attached.

(1) Sandbag topping. - The sack ordinarily used for topping an earth dike is a grain or feed sack which holds 100 pounds of grain. Smaller sacks may be used if feed sacks are not available. Grain sacks, filled with about one cubic foot of earth, weighing about 100 pounds, will provide a unit about 6 inches high, one foot wide and two feet in length.

(a) The sacks may be filled at the source of material and hauled to the dike or filled from stockpile or borrow areas at the dike, conditions determining the method employed. The same is true of filling; i. e., power or hand methods.

(b) The open end of the sacks shall always face upstream or toward the riverside of the dike and need not be sewed or tied. When the sack faces the river the loose end shall be folded under and when facing upstream the loose end covered by the succeeding sack.

(c) The front line of sandbags in the first layer shall be laid parallel to the dike center line and remaining bags at right angles to the center line. The sandbags in the second layer are all laid at right angles to the center line, the third row similar to the first and etc., as shown on Plate I, Appendix "D". All sacks shall be lapped about  $\frac{1}{3}$  each way and well mauled or tramped into place. The sacks shall be filled to  $\frac{2}{3}$  their capacity when flattened out to facilitate proper placing and prevent bursting the sack when mauled or tramped into place.

(d) Plate I, Appendix "D", illustrates the progressive method of increasing the dike height and gives an approximation of the number of sacks required for dikes of various heights.

(e) A crew of 50 men should fill, carry and place approximately 1500 sacks per 8-hour day, all hand labor, when the source of material is within 150 feet of the point of placement. Production will depend on conditions at the site.

## SECTION V

### FLOOD WALLS

5-01. Description. - a. A flood wall consisting of a reinforced concrete section on steel sheet piling extends from Station 5 + 39.42 to Station 7 + 43.42 as shown on Plate VII, Appendix "D".

b. Flood walls on the northerly and southerly edges of Bridge Street, as shown on Plate VIII, Appendix "D", are reinforced concrete, cantilever type walls.

5-02. Maintenance. - a. The following quotations from the regulations govern the maintenance of flood walls.

"Periodic inspections shall be made by the Superintendent to be certain that;

(1) No seepage, saturated areas, or sand boils are occurring;

(2) No undue settlement has occurred which affects the stability of the wall or its water tightness;

(3) No trees exist, the roots of which might extend under the wall and offer accelerated seepage paths;

(4) The concrete has not undergone cracking, chipping, or breaking to an extent which might affect the stability of the wall or its water tightness;

(5) There are no encroachments upon the right-of-way which might endanger the structure or hinder its functioning in time of flood;

(6) Care is being exercised to prevent accumulation of trash and debris adjacent to walls, and to insure that no fires are being built near them;

(7) No bank caving conditions exist riverward of the wall which might endanger its stability;

(8) Toe drainage systems and pressure relief wells are in good working condition, and that such facilities are not becoming clogged.

Such inspections shall be made immediately prior to the beginning of the flood season, immediately following each major high water

period, and otherwise at intervals not exceeding 90 days. Measures to eliminate encroachments and effect repairs found necessary by such inspections shall be undertaken immediately. All repairs shall be accomplished by methods acceptable in standard engineering practice."

b. The expansion joint material serves to protect the copper water stop against damage. When the expansion joint material has deteriorated to the point where it no longer serves its purpose the loose material should be cleaned out, and the joint poured full with asphalt. Care shall be exercised to protect the copper water stop.

5-03. Operation. - a. The following quotations from the regulations govern the operation of walls.

"Continuous patrol of the wall shall be maintained during flood periods to locate possible leakage at monolith joints or seepage underneath the wall. Floating plant or boats will not be allowed to lie against or tie up to the wall. Should it become necessary during a flood emergency to pass anchor cables over the wall, adequate measures shall be taken to protect the concrete and construction joints. Immediate steps shall be taken to correct any condition which endangers the stability of the wall."

b. The recommendations made in paragraph 4-03 b for dikes apply equally as well for the operations of the walls.

5-04. Emergency Repair Methods. - a. Sand boils. - See Section IV, Paragraph 4-04 c for a description and treatment of sand boils.

b. Monolith joints. - If vertical monolith joints have appreciable leakage, they can be controlled by dumping cinders, sand, or other such material on the riverside of the wall so the dumped material will be carried into the joint by the water thus plugging the leak.

c. Raising grade of wall. - In the event there is danger of the walls being overtopped by the flood, they can be raised safely to three feet above their present grade. This can be best accomplished by erecting wooden extensions such as shown on Plate V of Appendix "D".

(1) Notice of a flood that would overtop the walls will not allow sufficient time to construct and install the wooden extensions unless detailed plans regarding availability of personnel and materials are made in advance.

b. Pumping Station. - The pumping station is of reinforced concrete substructure and brick superstructure. It houses two electrically driven 30-inch propeller pumps and one electrically driven 12-inch volute pump. The station is located behind the dike at East Hollis Street and discharges through a conduit into the Merrimack River. An emergency overflow basin as shown on Plate X is provided to store sewage and drainage in the event that pumps should fail to start or function properly and in the event the inflow exceeds the pumping capacity.

c. Pumping Station Equipment. - (1) Electrical. - A 4160/2400 volt, 3 phase, 4 wire, overhead service is brought to the transformer substation by the Public Service Company of New Hampshire.

In the transformer substation there are three 75 KVA, 2400/480 volt, single phase transformers, Y-delta connected, supplying three phase power to the three pump motors. There is also located on the steel frame structure of the station a 3 KVA 2400/240/120 volt, single phase transformer supplying power for lighting and miscellaneous small power units. In order to avoid continuous loss of energy due to transformer no load losses, the 225 KVA bank should be normally disconnected on the power side and energized only for test runs and for actual use. The 3 KVA lighting transformer should be energized at all times.

Located within the pumping station is a two section, dead front air circuit breaker switchboard for the protection of the feeders and the control of the three pump motors. A voltmeter is provided on the board to check phase voltages and an ammeter is provided in each motor feeder to indicate the load on each pump motor at all times.

(2) Sluice Gates. - Two hand-operated 54" x 54" seating pressure sluice gates are installed within the pumping station - one closes the outlet of the gravity conduit at the rear wall of the pumping station, and the other closes the inlet to the wet sump for the 30-inch pumps as shown on Plate XI.

(3) Overflow Gate. - A 3'-6" x 4'-3" overflow gate with the invert set at Elevation 105.5 is provided for emergency diversion of flow to the emergency overflow basin, shown on Plates X and XI.

(4) Flap Valves. - The two 30-inch propeller pumps and the 12-inch volute pump are provided with flap valves on the discharge to facilitate starting of the pumps and prevent backflow. A 10-inch pipe and flap valve is provided between the inlet chamber and the overflow chamber for drainage of the emergency overflow basin at stages below Elevation 105.5 to prevent water backing up into overflow basin during high water.

(5) 30-inch Propeller Pumps. - The two 30-inch, single stage propeller pumps are driven by two 150 H.P. electric motors and have a capacity of 25,000 g.p.m. against a total head of 19 feet. Plate XII shows the 30" pump characteristic curves and Plate XIII shows the 150 H.P. motor performance curves.

(6) 12-inch Volute Pump. - The 12-inch volute pump is driven by a 34 H.P. motor, and has a capacity of 4,500 g.p.m. against a total head of 19 feet. Plate XIV shows the 12" pump characteristic curves and Plate XV shows the 30 H.P. motor performance curves.

(7) Trash Racks. - Vertical and horizontal type trash racks are located in the inlet chamber, as shown on Plate XI, to screen out any large objects that might clog or damage the pumps.

(8) Heating System. - A gas fired unit heater is installed in the pumping station to eliminate the necessity of draining the water system during the winter months and to prevent the severe system.

- (2) 30-inch Pump Motors: (2 installed)  
General Electric Company  
TriClad Induction Motor -- Model 5K-6335KE1  
Type K -- Code F -- Frame 6335P  
440 Volts -- 3 phase -- 60 cycle  
700 RPM -- 150 HP -- 190 Amps. Full Load
- (3) 12-inch Volute Pump;  
Morris Machine Works  
Non-clog Type -- 425 RPM -- 30 HP
- (4) 12-inch Pump Motor;  
General Electric Company  
TriClad Induction Motor -- Model 5K-6324ED1  
Type K -- Code E -- Frame 6324F  
440 Volts -- 3 phase -- 60 cycle  
425 RPM -- 30 HP -- 50 Amps. Full Load
- (5) Sluice Gates: (2 installed)  
Chapman Valve Manufacturing Company  
Size - 54 inch x 54 inch  
Type - Seating Pressure  
Hand operated floorstand
- (6) Crane;  
Milwaukee Crane Company  
3 Ton Army Type Hoist
- (7) Switchboard;  
General Electric Company
- (8) Gas Fired Heater;  
Clow Unit Heater  
Size 85 -- 6800 BTU Output
- (9) Sump Ventilator;  
ILG Electric Ventilating Company  
Model P -- No. 3374 -- 1750 RPM  
115 Volt -- Single phase -- 60 cycle -- 1/3 HP Motor

6-02. Maintenance. - a. The following is quoted from Paragraph 208.10 (f) (1) of the regulations prescribed by the Secretary of War to govern the maintenance and operation of flood control works:

"Pumping plants shall be inspected by the Superintendent at intervals not to exceed 30 days during flood season, and 90 days during off-flood seasons to insure that all equipment is in order for instant use. At regular intervals, proper measures shall be taken to provide

for cleaning plant, buildings, and equipment, repainting as necessary, and lubricating all machinery. Adequate supplies of lubricants for all types of machines, ----- and flash lights or lanterns for emergency lighting shall be kept on hand at all times. ----- All equipment, including switch gear, transformers, motors, pumps, valves, and gates shall be trial operated and checked at least once every 90 days. Megger tests of all insulation shall be made whenever wiring has been subjected to undue dampness and otherwise at intervals not to exceed one year. A record shall be kept showing the results of such tests. Wiring disclosed to be in unsatisfactory condition by such tests shall be brought to a satisfactory condition or shall be promptly replaced. ----- only skilled electricians and mechanics shall be employed on tests and repairs. ----- Any equipment removed from the station for repair or replacement shall be returned or replaced as soon as practicable, and shall be trial operated after reinstallation. Repairs requiring removal of equipment from the plant shall be made during off-flood seasons insofar as practicable."

b. General. - Proper maintenance of the pumping station requires periodic operation of all equipment at frequent intervals to keep equipment in good working order and all parts well lubricated and free from corrosion. It is recommended that whenever river conditions permit running the pump by recirculating the water, each pump be run for approximately six hours. This will permit the motors to get thoroughly warmed up and will help uncover any defects in the pumping equipment.

The gas fired unit heater in the pumping station should be left on in fall, winter and spring months with the thermostat set at 55° F and this temperature maintained in order to protect the equipment and insulation of the motors from severe moisture conditions due to condensation during these months.

c. Pumps. - (1) Briefly energize the motor on each pump once every two weeks by closing the circuit breaker for about 5 seconds. This will allow the motor and pumps to come up to speed and spread a film of oil over all bearings. DO NOT ALLOW PUMP TO RUN WITHOUT WATER FOR MORE THAN 15 SECONDS AS THE PUMP WILL BE SERIOUSLY DAMAGED.

(2) Inspect the impeller of each pump after it has been used for pumping and remove any debris that is lodged on or around the impeller.

(3) Lubricate all grease fittings with pressure grease gun every three months. The use of Keystone Velox No. 3 is recommended by some pump manufacturers.

d. Motors. - (1) Use SAE-20 bearing oil in the bearings of the motors.

(2) Drain bearings, flush with kerosene and refill once each year.

e. Electrical. - Plates XVI and XVII are curves on semi-logarithmic graph paper showing the insulation resistance versus temperature at time of manufacture for the stator windings of the ~~150 HP and 30 HP motors, respectively.~~ <sup>and rotor</sup> Measure the insulation resistance of the motor windings every six months and plot results as follows for each motor; <sup>40 HP motor at Riverdale Pumping Station</sup>

Plot the measured value of the insulation resistance and the temperature at which it was measured on the plate for the respective motor and draw a line through the plotted point parallel to the line on the plate. Read the insulation resistance value at point where the new line crosses the vertical line representing 60° C and plot this resistance value against time on Plate XVIII. This resistance obtained for each test and plotted on Plate XVIII will show any deterioration of the insulation. When any appreciable downward trend is observed in these insulation resistance values, an investigation should be made to determine the cause and corrective action taken. This will uncover the defects prior to actual breakdown. <sup>windings</sup>

6-03. Operation. - a. Paragraph 208.10 (f) (2) of the regulations prescribed by the Secretary of War to govern the maintenance and operation of flood control works is quoted below:

"Competent operators shall be on duty at pumping plants whenever it appears that necessity for pump operation is imminent. The operator shall thoroughly inspect, trial operate, and place in readiness all plant equipment. The operator shall be familiar with the equipment manufacturer's instructions and drawings and with the 'Operating Instructions' for each station. The equipment shall be operated in accordance with the above-mentioned 'Operating Instructions' and care shall be exercised that proper lubrication is being supplied all equipment, and that no overheating, undue vibration, or noise is occurring. Immediately upon final recession of flood waters, the pumping station shall be thoroughly cleaned, pump house sumps flushed, and equipment thoroughly inspected, oiled and greased. A record or log of pumping plant operation shall be kept for each station, a copy of which shall be furnished the Division Engineer following each flood."

b. Procedure for operating pumping station equipment. -

(1) When the need for pumping appears imminent

(a) Check all oil cups and grease fittings on the pumps and motors.

(b) Close the three fused disconnect switches on the primary of the transformer bank in the rear of the pumping station. Use the long wood pole which is furnished for this purpose.

(c) Check voltage on the switchboard by turning the voltmeter switch to each of the three positions and reading the voltage on each phase. The voltage on each phase should read between 400 and 480 volts. If voltage is under 400 volts contact the power company.

(d) Check cover plates in floor of pumping station over sewer outlet to make sure it is tightly bolted down.

(e) When liquid level indicator shows water elevation of 105.0, close sluice gate in outlet of sewer conduit and operate 12" volute pump.

(2) Operation of 12" volute pump. - (a) Open 14" gate valve in the pump suction and the 12" gate valve in the pump discharge.

(b) Open the 3/4" gate valve located on top of the volute casing. Allow all the air to bleed out of the pump. When water starts to flow out this valve, close valve.

(c) Start pump by closing the circuit breaker on the switchboard feeding the pump.

(d) Operate pump as required to maintain water level between elevation 102.0 and 106.0. Bleed air from pump casing every hour (see (2)(b) above). Inspect and clean trash racks as necessary for efficient operation.

Do not operate 12" volute pump for more than 15 seconds without water in it as the wearing rings of the pump are constructed with close tolerances and depend on water for lubrication and cooling.

(e) To stop pump, press "STOP" button in circuit breaker panel.

(f) When the inflow to the station exceeds the capacity of the volute pump, operate one, and if necessary both of the propeller pumps. The propeller pump, or pumps, may be operated in combination with the volute pump or alone, as required, to best suit pumping capacity to rate of inflow.

(3) Operation of 30" propeller pumps. - (a) Open sluice gate on intake to wet sump for 30" propeller pumps.

(b) Remove pipe cap from oil fill pipe located near the automatic lubricator on the pump base and pour about one-half pint of oil into the pipe to assure adequate lubrication of the pump bearings at the time of starting. This operation may be omitted if pump has been used within two or three weeks.

(c) Start pump by closing circuit breaker on the switchboard feeding the pump.

(d) Operate the 30" propeller pumps as required to maintain the water level between elevation 102.0 and 106.0.

(e) To stop pump press "STOP" button in circuit breaker panel.

(4) If the available pumping capacity is not sufficient to take care of the inflow, the emergency overflow basin shall be utilized when the water elevation in the wet sump exceeds elevation 106.0. To utilize this storage basin, pull pin in top of hinged steel gate which closes weir located in the sewer entrance conduit just in front of the station.

It is of utmost importance that this basin be kept normally empty and utilized only when available pumping capacity will not maintain the water level below elevation 106.0.

(5) When river stage drops to a reading of 15.0 (El. 102.2 m.s.l.) on the staff gage on the abutment of the Taylor Falls bridge;

(a) Stop all pumps.

(b) Open sluice gate in outlet of sewer conduit.

(c) Close gate valves on 12" volute pump when water elevation in sewer drops below suction intake to pump.

(d) Wash out wet sump with hose and close sluice gate on inlet to wet sump when water elevation in sewer drops below floor of wet sump.

## SECTION VII

### DRAINAGE STRUCTURES

7-01. Description. - a. The pumping station discharge conduit is located at East Hollis Street as shown on Plates VIII, X, and XI and described in Section VI.

b. A 24-inch diameter pipe discharges industrial waste from the Johns-Manville Company plant to the Nashua River, as shown on Plate VII. There is no gate on the outlet but the inlet is above design flood grade.

c. An 8-inch pipe discharges surface drainage to the Nashua River as shown on Plate VII. A flap valve is provided at the outlet end to prevent flood water backing into the protected area.

d. A catch basin in the Boston and Maine R. R. Yard at Station 38+00 conducts drainage into the protected area. A 10" valve is provided at the dike to prevent backup of water.

7-02. Maintenance. - a. The following quotations from the regulations govern the maintenance of drainage structures:

"Adequate measures shall be taken to insure that inlet and outlet channels are kept open and that trash, drift, or debris is not allowed to accumulate near drainage structures. Flap gates and manually operated gates and valves on drainage structures shall be examined, oiled and trial operated at least once every 90 days. Where drainage structures are provided with stop log or other emergency closures, the condition of the equipment and its housing shall be inspected regularly and a trial installation of the emergency closure shall be made at least once every year. Periodic inspections shall be made by the Superintendent to be certain that:

"(1) Pipes, gates, operating mechanism, riprap and headwalls are in good condition;

"(2) Inlet and outlet channels are open;

"(3) Care is being exercised to prevent the accumulation of trash and debris near the structures and to insure that no fires are being built near bituminous coated pipes;

"(4) Erosion which might endanger water-tightness or stability is not occurring adjacent to structures."

Immediate steps will be taken to repair damage, replace missing or broken parts, or remedy adverse conditions disclosed by such inspections. The pressure cover on Manhole "H" of the 24" pressure conduit shall be securely bolted at all times.

7-C3. Operation. - The following quotations from the regulations govern the operation of drainage structures:

"Whenever high water conditions impend, all gates will be inspected a short time before water reaches the invert of the pipe and any object which might prevent closure of the gate shall be removed. Automatic gates shall be closely observed until it has been ascertained that they are securely closed. Manually operated gates and valves shall be closed as necessary to prevent inflow of flood water. All drainage structures in levees shall be inspected frequently during floods to ascertain whether seepage is taking place along the lines of their contact with the embankment. Immediate steps shall be taken to correct any adverse conditions."

## SECTION VIII

### DRAWINGS

8-01. Drawings. - A set of drawings and specifications for the dike and pumping station has been delivered to the City of Nashua. The project was formally turned over to the City on August 29, 1949 and was accepted August 30, 1949.

APPENDIX "A"

REGULATIONS PRESCRIBED BY THE SECRETARY OF WAR PAGE A-1

## TITLE 33—NAVIGATION AND NAVIGABLE WATERS

### Chapter II—Corps of Engineers, War Department

#### PART 208—FLOOD CONTROL REGULATIONS MAINTENANCE AND OPERATION OF FLOOD CONTROL WORKS

Pursuant to the provisions of section 3 of the Act of Congress approved June 22, 1936, as amended and supplemented (49 Stat. 1571; 50 Stat. 877; and 55 Stat. 638; 33 U. S. C. 701c; 701c-1), the following regulations are hereby prescribed to govern the maintenance and operation of flood control works:

§ 208.10 *Local flood protection works; maintenance and operation of structures and facilities*—(a) *General*. (1) The structures and facilities constructed by the United States for local flood protection shall be continuously maintained in such a manner and operated at such times and for such periods as may be necessary to obtain the maximum benefits.

(2) The State, political subdivision thereof, or other responsible local agency, which furnished assurance that it will maintain and operate flood control works in accordance with regulations prescribed by the Secretary of War, as required by law, shall appoint a permanent committee consisting of or headed by an official hereinafter called the "Superintendent," who shall be responsible for the development and maintenance of, and directly in charge of, an organization responsible for the efficient operation and maintenance of all of the structures and facilities during flood periods and for continuous inspection and maintenance of the project works during periods of low water, all without cost to the United States.

(3) A reserve supply of materials needed during a flood emergency shall be kept on hand at all times.

(4) No encroachment or trespass which will adversely affect the efficient operation or maintenance of the project works shall be permitted upon the right-of-way for the protective facilities.

(5) No improvement shall be passed over, under, or through the walls, levees, improved channels or floodways, nor shall any excavation or construction be permitted within the limits of the project right-of-way, nor shall any change be made in any feature of the works without prior determination by the District Engineer of the War Department or his authorized representative that such improvement, excavation, construction, or alteration will not adversely affect the functioning of the protective facilities. Such improvements or alterations as may be found to be desirable and permissible under the above determination shall be constructed in accordance with standard engineering practice. Advice regarding the effect of proposed improvements or alterations on the functioning of the project and information concerning methods of construction acceptable under standard engineering practice shall be obtained from the District Engineer or, if otherwise obtained, shall be submitted for his approval. Drawings or prints showing such improvements or alterations as finally constructed shall be furnished the District Engineer after completion of the work.

(6) It shall be the duty of the superintendent to submit a semiannual report to the District Engineer covering inspection, maintenance, and operation of the protective works.

(7) The District Engineer or his authorized representatives shall have access at all times to all portions of the protective works.

(8) Maintenance measures or repairs which the District Engineer deems necessary shall be promptly taken or made.

(9) Appropriate measures shall be taken by local authorities to insure that the activities of all local organizations operating public or private facilities connected with the protective works are coordinated with those of the Superintendent's organization during flood periods.

(10) The War Department will furnish local interests with an Operation and Maintenance Manual for each completed project, or separate useful part thereof, to assist them in carrying out their obligations under these regulations.

(b) *Levees*—(1) *Maintenance*. The Superintendent shall provide at all times such maintenance as may be required to insure serviceability of the structures in time of flood. Measures shall be taken to promote the growth of sod, exterminate burrowing animals, and to provide for routine mowing of the grass and weeds, removal of wild growth and drift deposits, and repair of damage caused by erosion or other forces. Where practicable, measures shall be taken to retard bank erosion by planting of willows or other suitable growth on areas riverward of the levees. Periodic inspections shall be made by the Superintendent to insure that the above maintenance measures are being effectively carried out and, further, to be certain that:

(i) No unusual settlement, sloughing, or material loss of grade or levee cross section has taken place;

(ii) No caving has occurred on either the land side or the river side of the levee which might affect the stability of the levee section;

(iii) No seepage, saturated areas, or sand boils are occurring;

(iv) Toe drainage systems and pressure relief wells are in good working condition, and that such facilities are not becoming clogged;

(v) Drains through the levees and gates on said drafts are in good working condition;

(vi) No revetment work or riprap has been displaced, washed out, or removed;

(vii) No action is being taken; such as burning grass and weeds during inappropriate seasons, which will retard or destroy the growth of sod;

(viii) Access roads to and on the levee are being properly maintained;

(ix) Cattle guards and gates are in good condition;

(x) Crown of levee is shaped so as to drain readily, and roadway thereon, if any, is well shaped and maintained;

(xi) There is no unauthorized grazing or vehicular traffic on the levees;

(xii) Encroachments are not being made on the levee right-of-way which might endanger the structure or hinder its proper and efficient functioning during times of emergency.

Such inspections shall be made immediately prior to the beginning of the flood season; immediately following each major high water period, and otherwise at intervals not exceeding 90 days; and such intermediate times as may be necessary to insure the best possible care of

the levee. Immediate steps will be taken to correct dangerous conditions disclosed by such inspections. Regular maintenance repair measures shall be accomplished during the appropriate season as scheduled by the Superintendent.

(2) *Operation*. During flood periods the levee shall be patrolled continuously to locate possible sand boils or unusual wetness of the landward slope and to be certain that:

(i) There are no indications of slides or sloughs developing;

(ii) Wave wash or scouring action is not occurring;

(iii) No low reaches of levee exist which may be overtopped;

(iv) No other conditions exist which might endanger the structure.

Appropriate advance measures will be taken to insure the availability of adequate labor and materials to meet all contingencies. Immediate steps will be taken to control any condition which endangers the levee and to repair the damaged section.

(c) *Flood walls*—(1) *Maintenance*. Periodic inspections shall be made by the Superintendent to be certain that:

(i) No seepage, saturated areas, or sand boils are occurring;

(ii) No undue settlement has occurred which affects the stability of the wall or its water tightness;

(iii) No trees exist, the roots of which might extend under the wall and offer accelerated seepage paths;

(iv) The concrete has not undergone cracking, chipping, or breaking to an extent which might affect the stability of the wall or its water tightness;

(v) There are no encroachments upon the right-of-way which might endanger the structure or hinder its functioning in time of flood;

(vi) Care is being exercised to prevent accumulation of trash and debris adjacent to walls, and to insure that no fires are being built near them;

(vii) No bank caving conditions exist riverward of the wall which might endanger its stability;

(viii) Toe drainage systems and pressure relief wells are in good working condition, and that such facilities are not becoming clogged.

Such inspections shall be made immediately prior to the beginning of the flood season, immediately following each major high water period, and otherwise at intervals not exceeding 90 days. Measures to eliminate encroachments and effect repairs found necessary by such inspections shall be undertaken immediately. All repairs shall be accomplished by methods acceptable in standard engineering practice.

(2) *Operation*. Continuous patrol of the wall shall be maintained during flood periods to locate possible leakage at monolith joints or seepage underneath the wall. Floating plant or boats will not be allowed to lie against or tie up to the wall. Should it become necessary during a flood emergency to pass anchor cables over the wall, adequate measures shall be taken to protect the concrete and construction joints. Immediate steps shall be taken to correct any condition which endangers the stability of the wall.

(d) *Drainage structures*—(1) *Maintenance*. Adequate measures shall be taken to insure that inlet and outlet channels are kept open and that trash, drift, or debris is not allowed to accumulate near drainage structures. Flap gates and manually operated gates and valves on

drainage structures shall be examined, oiled, and trial operated at least once every 90 days. Where drainage structures are provided with stop log or other emergency closures, the condition of the equipment and its housing shall be inspected regularly and a trial installation of the emergency closure shall be made at least once each year. Periodic inspections shall be made by the Superintendent to be certain that:

(i) Pipes, gates, operating mechanism, riprap, and headwalls are in good condition;

(ii) Inlet and outlet channels are open;

(iii) Care is being exercised to prevent the accumulation of trash and debris near the structures and that no fires are being built near bituminous coated pipes;

(iv) Erosion is not occurring adjacent to the structure which might endanger its water tightness or stability.

Immediate steps will be taken to repair damage, replace missing or broken parts, or remedy adverse conditions disclosed by such inspections.

(2) *Operation.* Whenever high water conditions impend, all gates will be inspected a short time before water reaches the invert of the pipe and any object which might prevent closure of the gate shall be removed. Automatic gates shall be closely observed until it has been ascertained that they are securely closed. Manually operated gates and valves shall be closed as necessary to prevent inflow of flood water. All drainage structures in levees shall be inspected frequently during floods to ascertain whether seepage is taking place along the lines of their contact with the embankment. Immediate steps shall be taken to correct any adverse condition.

(c) *Closure structures*—(1) *Maintenance.* Closure structures for traffic openings shall be inspected by the superintendent every 90 days to be certain that:

(i) No parts are missing;

(ii) Metal parts are adequately covered with paint;

(iii) All movable parts are in satisfactory working order,

(iv) Proper closure can be made promptly when necessary;

(v) Sufficient materials are on hand for the erection of sand bag closures and that the location of such materials will be readily accessible in times of emergency.

Tools and parts shall not be removed for other use. Trial erections of one or more closure structures shall be made once each year, alternating the structures chosen so that each gate will be erected at least once in each 3-year period. Trial erection of all closure structures shall be made whenever a change is made in key operating personnel. Where railroad operation makes trial erection of a closure structure infeasible, rigorous inspection and drill of operating personnel may be substituted therefor. Trial erection of sand bag closures is not required. Closure materials will be carefully checked prior to and following flood periods, and damaged or missing parts shall be repaired or replaced immediately.

(2) *Operation.* Erection of each movable closure shall be started in sufficient time to permit completion before flood waters reach the top of the structure sill. Information regarding the proper method of erecting each individual closure structure, together with an estimate of the time required by an experienced crew to complete its erection will be given

in the Operation and Maintenance Manual which will be furnished local interests upon completion of the project. Closure structures will be inspected frequently during flood periods to ascertain that no undue leakage is occurring and that drains provided to care for ordinary leakage are functioning properly. Boats or floating plant shall not be allowed to tie up to closure structures or to discharge passengers or cargo over them.

(f) *Pumping plants*—(1) *Maintenance.* Pumping plants shall be inspected by the Superintendent at intervals not to exceed 30 days during flood seasons and 90 days during off-flood seasons to insure that all equipment is in order for instant use. At regular intervals, proper measures shall be taken to provide for cleaning plant, buildings, and equipment, repainting as necessary, and lubricating all machinery. Adequate supplies of lubricants for all types of machines, fuel for gasoline or diesel powered equipment, and flash lights or lanterns for emergency lighting shall be kept on hand at all times. Telephone service shall be maintained at pumping plants. All equipment, including switch gear, transformers, motors, pumps, valves, and gates shall be trial operated and checked at least once every 90 days. Megger tests of all insulation shall be made whenever wiring has been subjected to undue dampness and otherwise at intervals not to exceed one year. A record shall be kept showing the results of such tests. Wiring disclosed to be in an unsatisfactory condition by such tests shall be brought to a satisfactory condition or shall be promptly replaced. Diesel and gasoline engines shall be started at such intervals and allowed to run for such length of time as may be necessary to insure their serviceability in times of emergency. Only skilled electricians and mechanics shall be employed on tests and repairs. Operating personnel for the plant shall be present during tests. Any equipment removed from the station for repair or replacement shall be returned or replaced as soon as practicable and shall be trial operated after reinstallation. Repairs requiring removal of equipment from the plant shall be made during off-flood seasons insofar as practicable.

(2) *Operation.* Competent operators shall be on duty at pumping plants whenever it appears that necessity for pump operation is imminent. The operator shall thoroughly inspect, trial operate, and place in readiness all plant equipment. The operator shall be familiar with the equipment manufacturers' instructions and drawings and with the "Operating Instructions" for each station. The equipment shall be operated in accordance with the above-mentioned "Operating Instructions" and care shall be exercised that proper lubrication is being supplied all equipment, and that no overheating, undue vibration or noise is occurring. Immediately upon final recession of flood waters, the pumping station shall be thoroughly cleaned, pump house sumps flushed, and equipment thoroughly inspected, oiled and greased. A record or log of pumping plant operation shall be kept for each station, a copy of which shall be furnished the District Engineer following each flood.

(g) *Channels and floodways* — (1) *Maintenance.* Periodic inspections of improved channels and floodways shall be made by the Superintendent to be certain that:

(i) The channel or floodway is clear of debris, weeds, and wild growth;

(ii) The channel or floodway is not being restricted by the depositing of waste materials, building of unauthorized structures or other encroachments;

(iii) The capacity of the channel or floodway is not being reduced by the formation of shoals;

(iv) Banks are not being damaged by rain or wave wash, and that no sloughing of banks has occurred;

(v) Riprap sections and deflection dikes and walls are in good condition;

(vi) Approach and egress channels adjacent to the improved channel or floodway are sufficiently clear of obstructions and debris to permit proper functioning of the project works.

Such inspections shall be made prior to the beginning of the flood season and otherwise at intervals not to exceed 90 days. Immediate steps will be taken to remedy any adverse conditions disclosed by such inspections. Measures will be taken by the Superintendent to promote the growth of grass on bank slopes and earth deflection dikes. The Superintendent shall provide for periodic repair and cleaning of debris basins, check dams, and related structures as may be necessary.

(2) *Operation.* Both banks of the channel shall be patrolled during periods of high water, and measures shall be taken to protect those reaches being attacked by the current or by wave wash. Appropriate measures shall be taken to prevent the formation of jams of ice or debris. Large objects which become lodged against the bank shall be removed. The improved channel or floodway shall be thoroughly inspected immediately following each major high water period. As soon as practicable thereafter, all snags and other debris shall be removed and all damage to banks, riprap, deflection dikes and walls, drainage outlets, or other flood control structures repaired.

(h) *Miscellaneous facilities* — (1) *Maintenance.* Miscellaneous structures and facilities constructed as a part of the protective works and other structures and facilities which function as a part of, or affect the efficient functioning of the protective works, shall be periodically inspected by the Superintendent and appropriate maintenance measures taken. Damaged or unserviceable parts shall be repaired or replaced without delay. Areas used for ponding in connection with pumping plants or for temporary storage of interior run-off during flood periods shall not be allowed to become filled with silt, debris, or dumped material. The Superintendent shall take proper steps to prevent restriction of bridge openings and, where practicable, shall provide for temporary raising during floods of bridges which restrict channel capacities during high flows.

(2) *Operation.* Miscellaneous facilities shall be operated to prevent or reduce flooding during periods of high water. Those facilities constructed as a part of the protective works shall not be used for purposes other than flood protection without approval of the District Engineer unless designed therefor. (49 Stat. 1571, 50 Stat. 877; and 55 Stat. 638; 33 U.S.C. 701c; 701c-1) (Regs. 9 August 1944, CE SPEWFF)

[SEAL]

J. A. ULIO,  
Major General,  
The Adjutant General.

[F. R. Doc. 44-12285; Filed, August 16, 1944;  
9:44 a. m.]

APPENDIX "B"

ASSURANCES OF LOCAL COOPERATION

## RESOLUTION

PERTAINING TO A PROPOSED FLOOD CONTROL PROJECT IN THE  
CITY OF NASHUA BY THE UNITED STATES GOVERNMENT UNDER  
THE DIRECTION OF THE SECRETARY OF WAR AND SUPERVISION  
OF THE CHIEF OF ENGINEERS.

### CITY OF NASHUA

In the Year of Our Lord One Thousand Nine Hundred and forty-  
four,

RESOLVED, By the Board of Aldermen of the City  
of Nashua

Whereas, under the authority of Flood Control Act of 1938, approved by the President on June 28, 1938, which provides in part that "in addition to the construction of a system of flood control reservoirs, related flood control works which may be found justified by the Chief of Engineers", funds have been allotted by the Federal Government for the preparation of definite project plans for flood protection in the City of Nashua, State of New Hampshire:

Whereas, Section 3 of the Flood Control Act approved June 22, 1936, provides that "no money --- shall be expended on the construction of any project until --- responsible local agencies have given assurances satisfactory to the Secretary of War that they will, (a) provide without cost to the United States all lands, easements, and rights-of-way necessary for the construction of the project, --- (b) hold and save the United States free from damages due to the construction works, (c) maintain and operate all the works after completion in accordance with regulations prescribed by the Secretary of War:---":

Whereas, the proposed improvements at Nashua, New Hampshire, will be prosecuted under the direction of the Secretary of War and supervision of the Chief of Engineers, and

Whereas, the plans for the proposed improvements will be for the benefit principally of the inhabitants of Nashua, New Hampshire,

NOW, THEREFORE, BE IT RESOLVED, that upon approval of the Chief of Engineers of the definite project plans and the allotment of funds for the proposed works of improvement, the City of Nashua will, (a) furnish without cost to the United States all lands, easements, and rights-of-way necessary for said works. The lands, easements, and rights-of-way which said City of Nashua shall furnish shall include those needed for the sites of structures, for spoil disposal areas, for access roads, and all

other rights in, upon, through or over private property which are needed by the United States in connection with the work of improvement. Maps showing the lands, easements, or rights-of-way needed for the aforesaid work will be obtained by the City of Nashua from the United States. Detailed property surveys and title searches necessary to acquire the land or interests therein will be performed by the City; (b) that the Mayor of the City of Nashua, New Hampshire, be and hereby is authorized to execute, acknowledge, and deliver, for and on behalf of the City of Nashua, to the United States any and all instruments which may be required by the United States in order to prosecute the proposed work of improvement, and to authorize and permit the said United States to act for and on behalf of the City of Nashua, New Hampshire, under any easements, grants or rights-of-way that have been obtained by or may be hereafter obtained by said City of Nashua in connection with said proposed improvement.

Be it further resolved that the said City of Nashua, New Hampshire, will hold and save the United States, its officers and employees, free from all claims for damages and from all liabilities due to the construction work and upon completion of the proposed flood control works the City of Nashua will accept the same and will maintain and operate them without expense to the United States in accordance with regulations prescribed by the Secretary of War.

IN THE BOARD OF ALDERMEN

First Reading	May 9, 1944
Second Reading	June 13, 1944
Passed	June 13, 1944

Attest:

Irenee D. Ravenelle  
City Clerk

Edward R. Benoit  
President

Approved  
June 16, 1944

Eugene H. Lemay  
Mayor

The foregoing is a true copy of the Resolution thereon.

Attest:

/s/ Irenee D. Ravenelle  
Irenee D. Ravenelle,  
City Clerk.

Nashua, N. H. June 16, 1944

APPENDIX "C"

PAGE

INSPECTION REPORT FORMS

Dike Inspection Report

C-1

Pumping Station Inspection Report

C-3

APPENDIX "D"

DRAWINGS

PLATE

STANDARD HIGHWATER MAINTENANCE METHODS

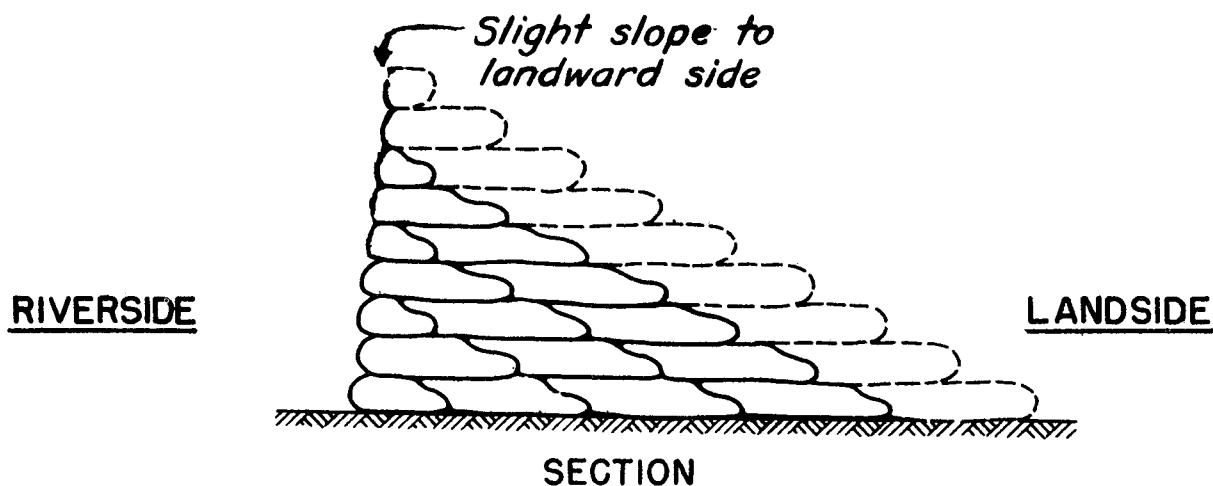
Sack Dike or Topping	I
Model Sack Dike or Topping	IA
Lumber and Sack Topping	II
Sand Boil	III
Effect of Sand Boils on Levee	IIIA
Sacking Sloughs	IV
Emergency Flash Boards	V

PLANS AND PROFILES

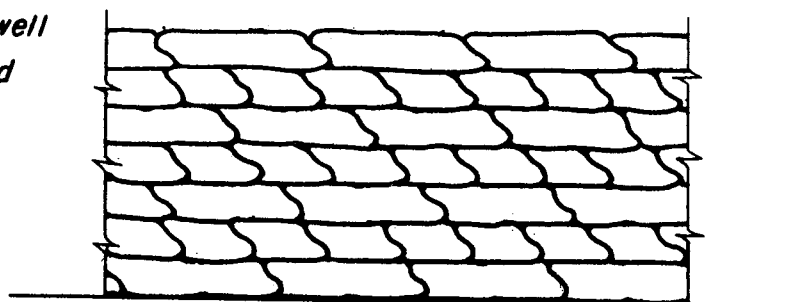
Project Map	VI
General Plan and Profile, Sta. 0 + 00 to Sta. 17 + 45	VII
General Plan and Profile, Sta. 17 + 45 to Sta. 38 + 0	VIII
Typical Dike and Flood Wall Sections	IX
Pumping Station Area, Plan and Sections	X
Pumping Station, Arrangement of Equipment	XI

PUMP CHARACTERISTIC CURVES

30" Propeller Pump Characteristic Curve	XII
150 H.P. Motor Performance Curve	XIII
150 H.P. Motor Insulation Resistance Curve	XIV
12" Propeller Pump Characteristic Curve	XV
30 H.P. Motor Performance Curve	XVI
30 H.P. Motor Insulation Resistance Curve	XVII
Insulation Resistance Instruction Sheet	XVIII



*Note: Sacks should be lapped at least  $\frac{1}{3}$  all ways and well mauled or tamped into place.*



### RIVERSIDE ELEVATION

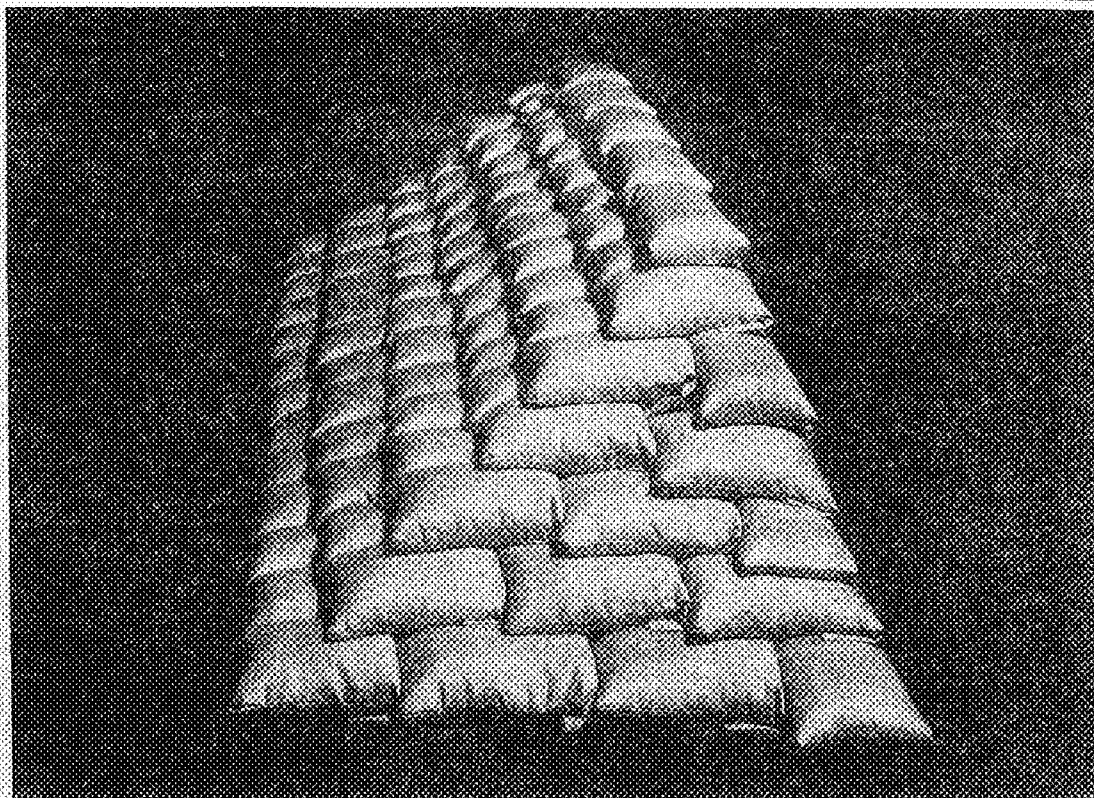
SACKS REQUIRED PER 100' STA.  
100 lb. "Feed" Sacks - 1 Cu. Ft. Each

Approx. Hgt. Sack Dike	Sacks High	Required
1.5	3	300
2.0	4	750
3.0	6	1400
4.0	8	2250
5.0	10	3250
6.0	12	4500
7.0	14	5950
8.0	16	7600

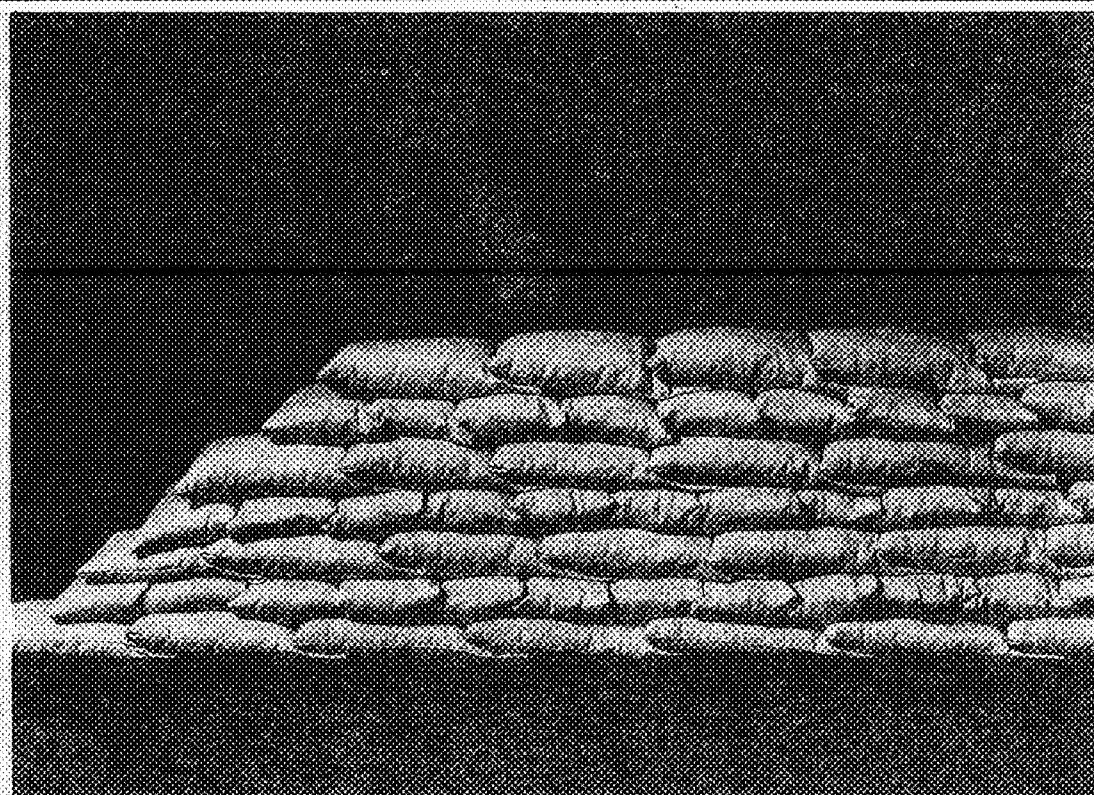
### SACK DIKE OR TOPPING STANDARD HIGH WATER MAINTENANCE INSTRUCTION

#### FLOOD EMERGENCY MOBILIZATION PLAN

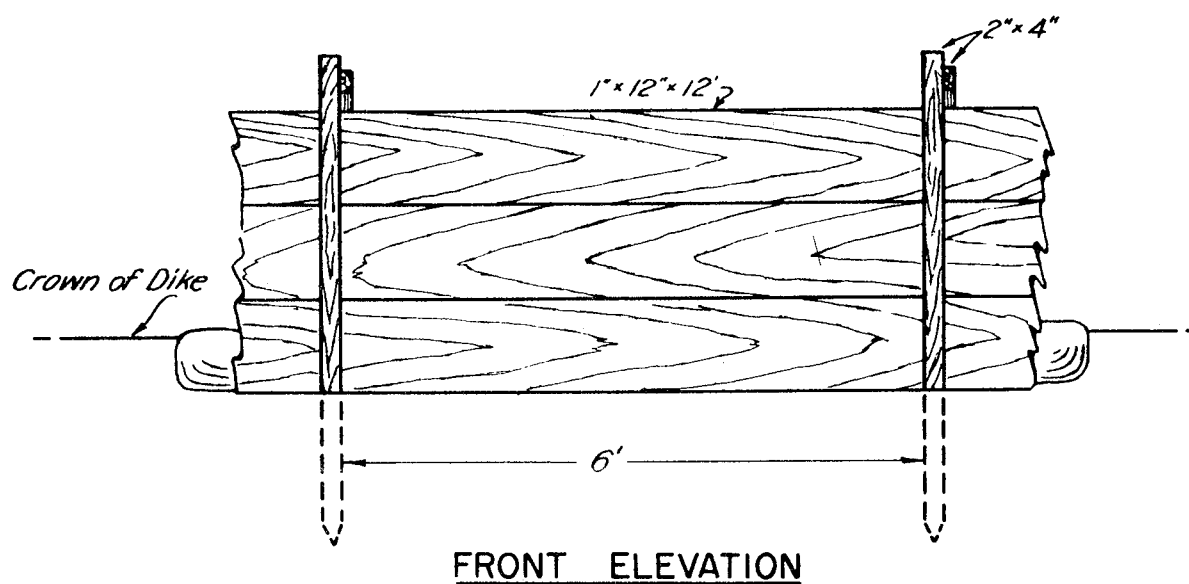
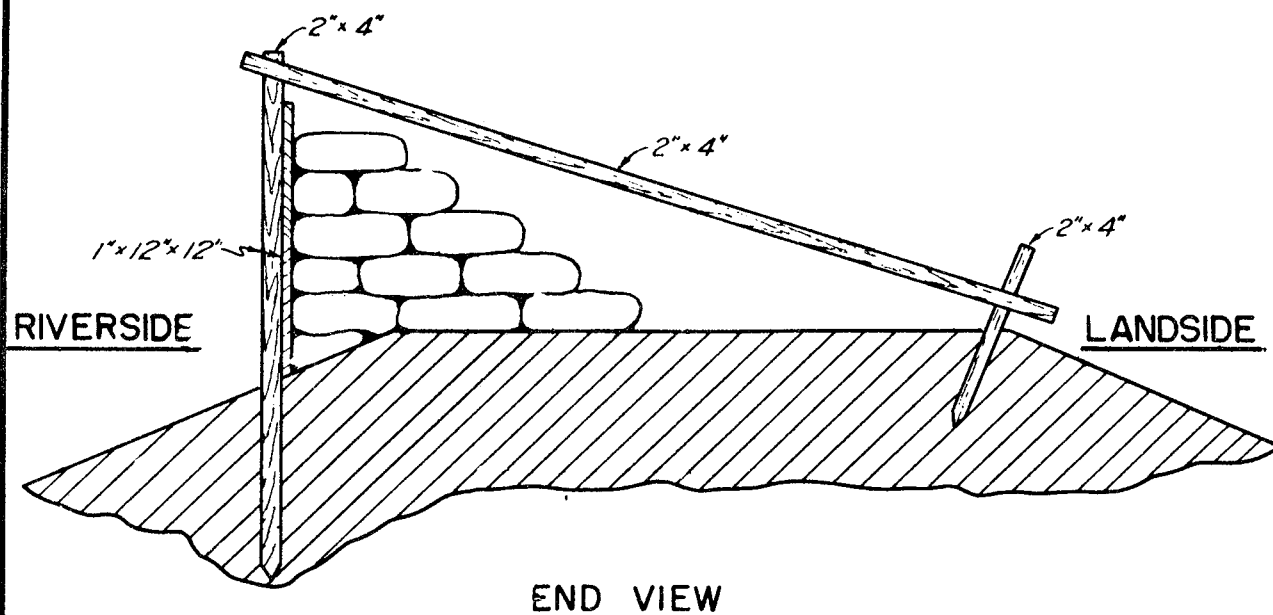
PREPARED BY  
CORPS OF ENGINEERS, U.S. ARMY  
OFFICE OF THE DIVISION ENGINEER  
NEW ENGLAND DIVISION, BOSTON, MASS.



MODEL SACK DIKE OR TOPPING  
Typical Section



MODEL SACK DIKE OR TOPPING  
Riverside View



BILL OF MATERIAL TO CONSTRUCT 100 FEET

25 pcs. 1" x 12" x 12'

17 pcs. 2" x 4" x 6'

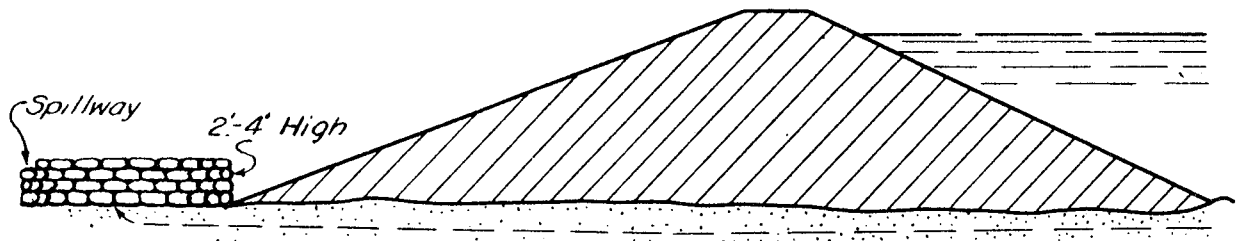
17 pcs. 2" x 4" x 10'

17 pcs 2" x 4" x 2'

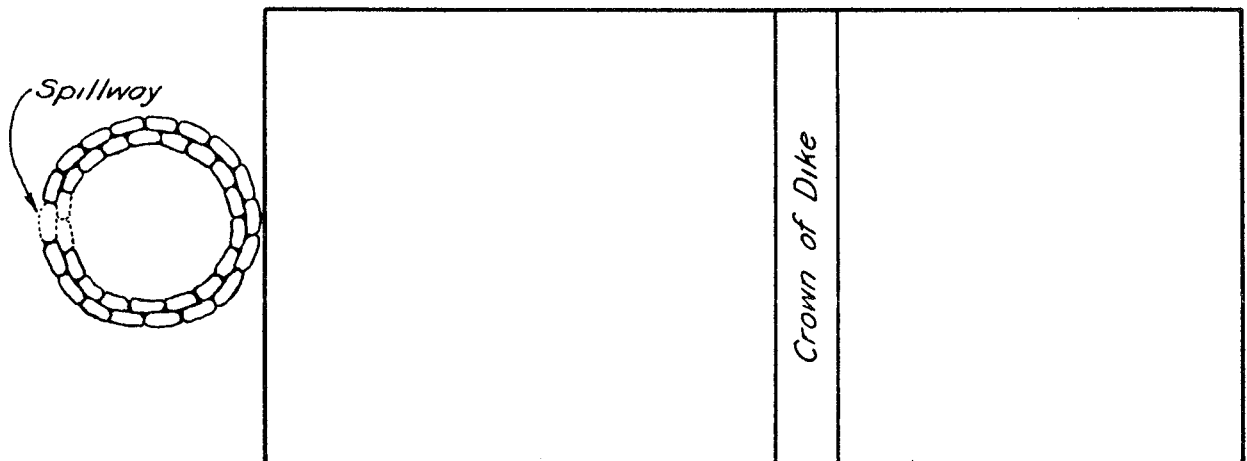
**LUMBER AND SACK TOPPING  
STANDARD HIGH WATER  
MAINTENANCE INSTRUCTION**

**FLOOD EMERGENCY MOBILIZATION PLAN**

PREPARED BY  
CORPS OF ENGINEERS, U.S. ARMY  
OFFICE OF THE DIVISION ENGINEER  
NEW ENGLAND DIVISION, BOSTON, MASS



Wall should be built on firm ELEVATION foundation, with width of base at least  $1\frac{1}{2}$  times the height. Be sure to place sacks on ground clear of sand discharge. Tie into dike if boil is near toe.



PLAN

*Do not sack boil which does not put out material. Height of sack loop or ring should be only sufficient to create enough head to slow down flow through boil so that no more material is displaced and boil runs clear. Do not try to stop fully, flow through boil.*

### SAND BOIL STANDARD HIGH WATER MAINTENANCE INSTRUCTION

FLOOD EMERGENCY MOBILIZATION PLAN

PREPARED BY  
CORPS OF ENGINEERS, U.S. ARMY  
OFFICE OF THE DIVISION ENGINEER  
NEW ENGLAND DIVISION, BOSTON, MASS.

# EFFECTS OF SAND BOILS ON LEVEE

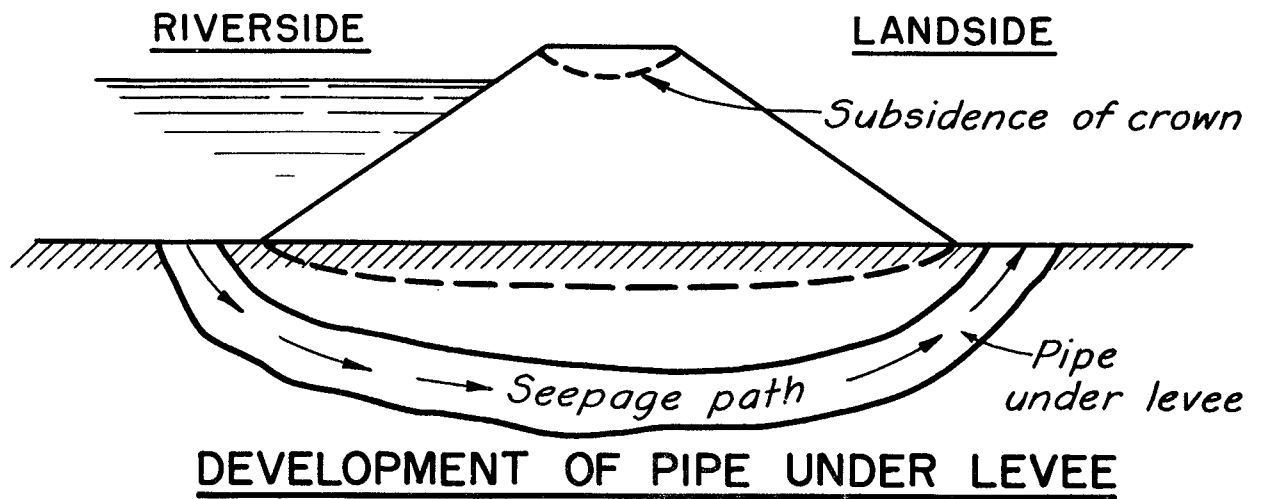


Fig. 1

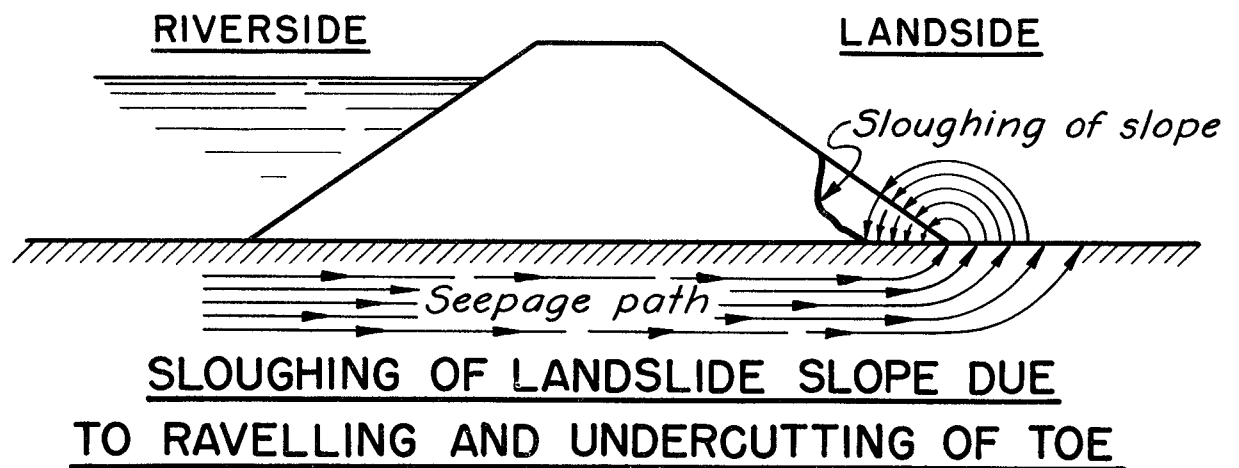


Fig. 2

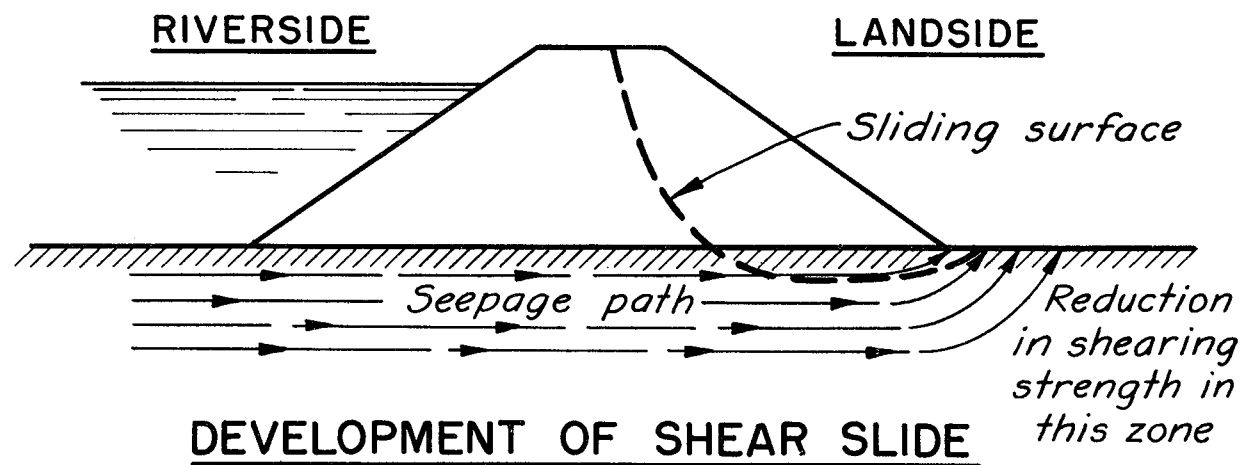
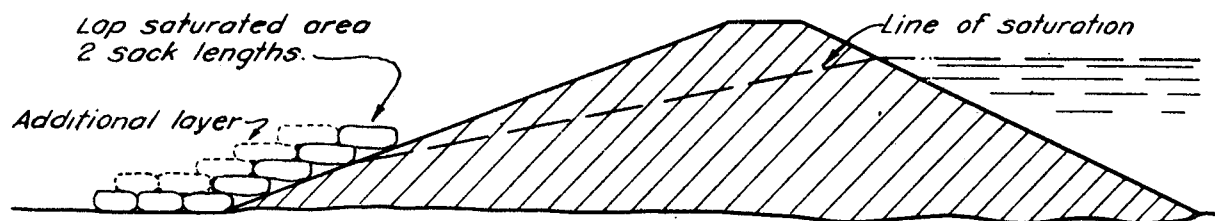
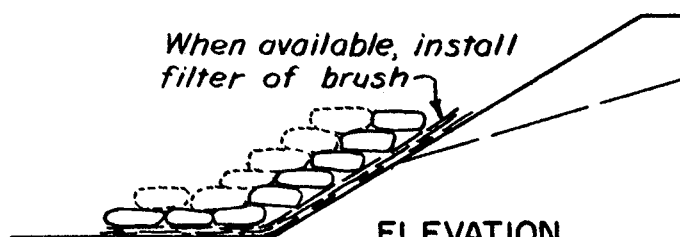


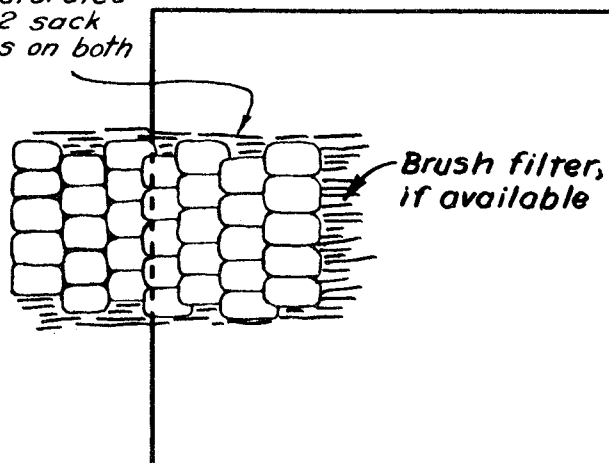
Fig. 3

ELEVATION

*Number of layers determined by velocity of seepage and amount of material being carried*

ELEVATION

*Lap saturated area 2 sack widths on both ends.*

PLAN

*Sacks should be laid shingle fashion and not matted into place.*

## SACKING SLOUGHS STANDARD HIGH WATER MAINTENANCE INSTRUCTION

FLOOD EMERGENCY MOBILIZATION PLAN

PREPARED BY  
CORPS OF ENGINEERS, U.S. ARMY  
OFFICE OF THE DIVISION ENGINEER  
NEW ENGLAND DIVISION, BOSTON, MASS.



BILL OF MATERIALS			
For one 8'-0" panel. Regular wall section.			
Uprights	10 pcs	2' x 4" x 6'-0"	
Vert. brace	5 "	2' x 4" x 3'-0"	
Stringers	5 "	1' x 6" x 8'-0"	
Upper ties	5 "	1' x 6" x 2'-3"	
Lower ties	5 "	1' x 4" x 2'-3"	
Diagonals	5 "	1' x 4" x 3'-6"	
Sheathing	6'	1' x 6" x 8'-0" or random	widths to make up 36'



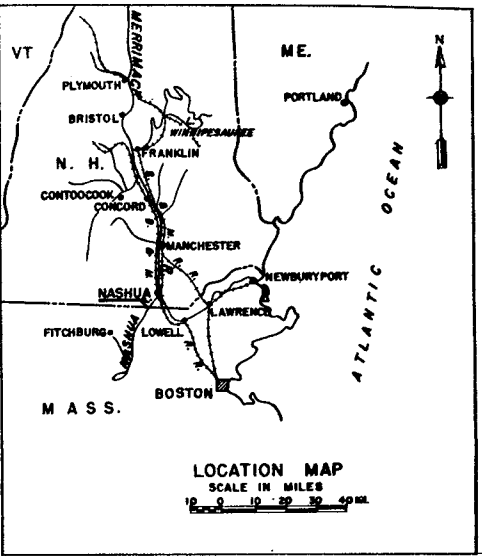
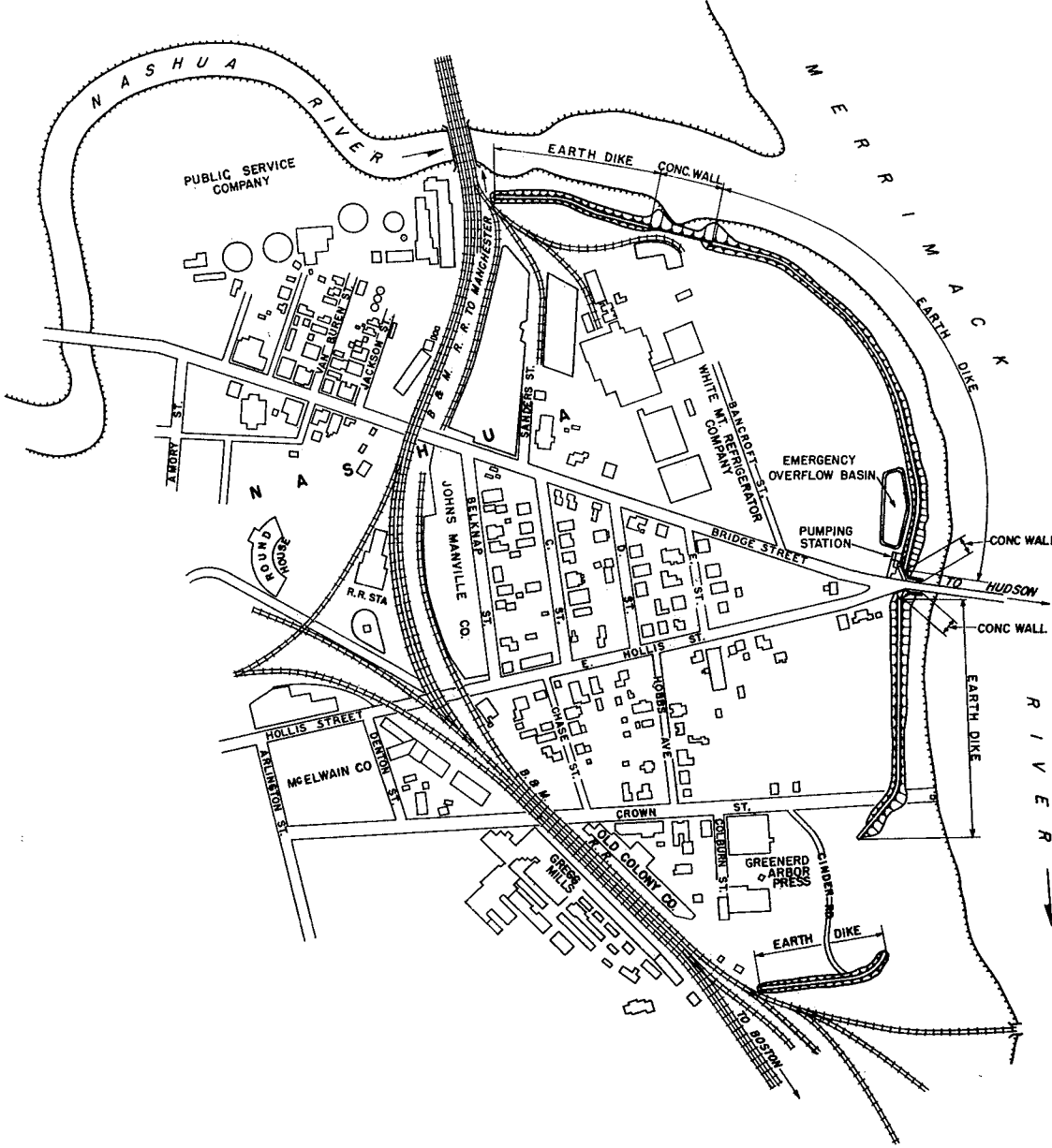
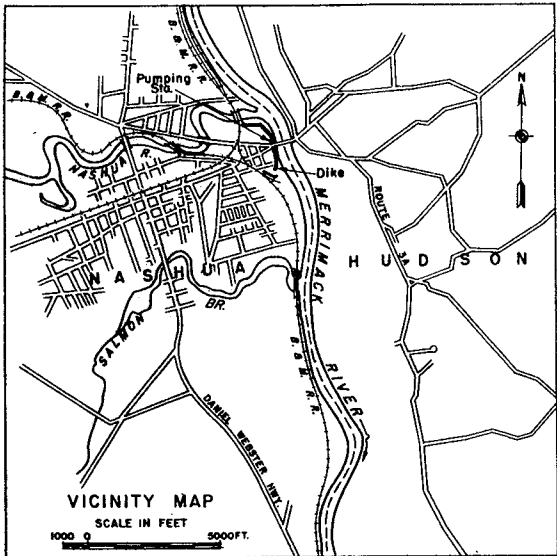
**MERRIMACK RIVER FLOOD CONTROL**

**FLOOD PROTECTIVE WORKS**  
**NASHUA, N.H.**

**OPERATION AND MAINTENANCE MANUAL**  
**EMERGENCY FLASH BOARDS**  
**FOR FLOOD WALLS**

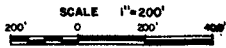
**MERRIMACK RIVER** **NEW HAMPSHIRE**

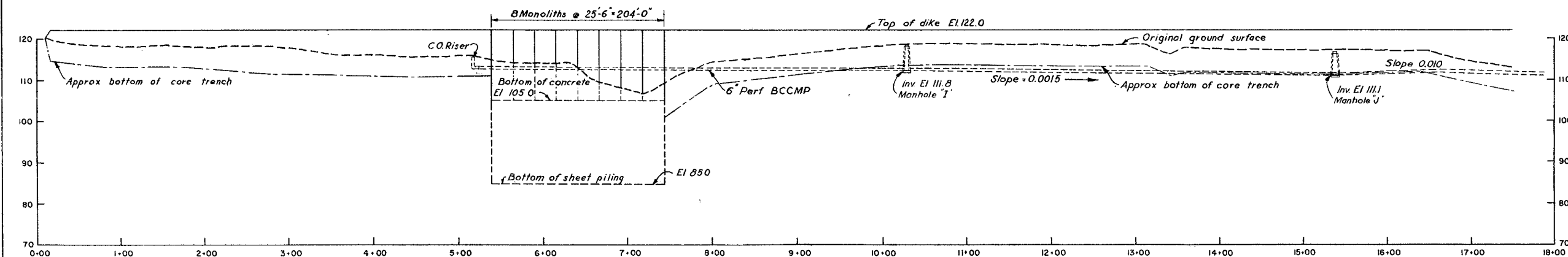
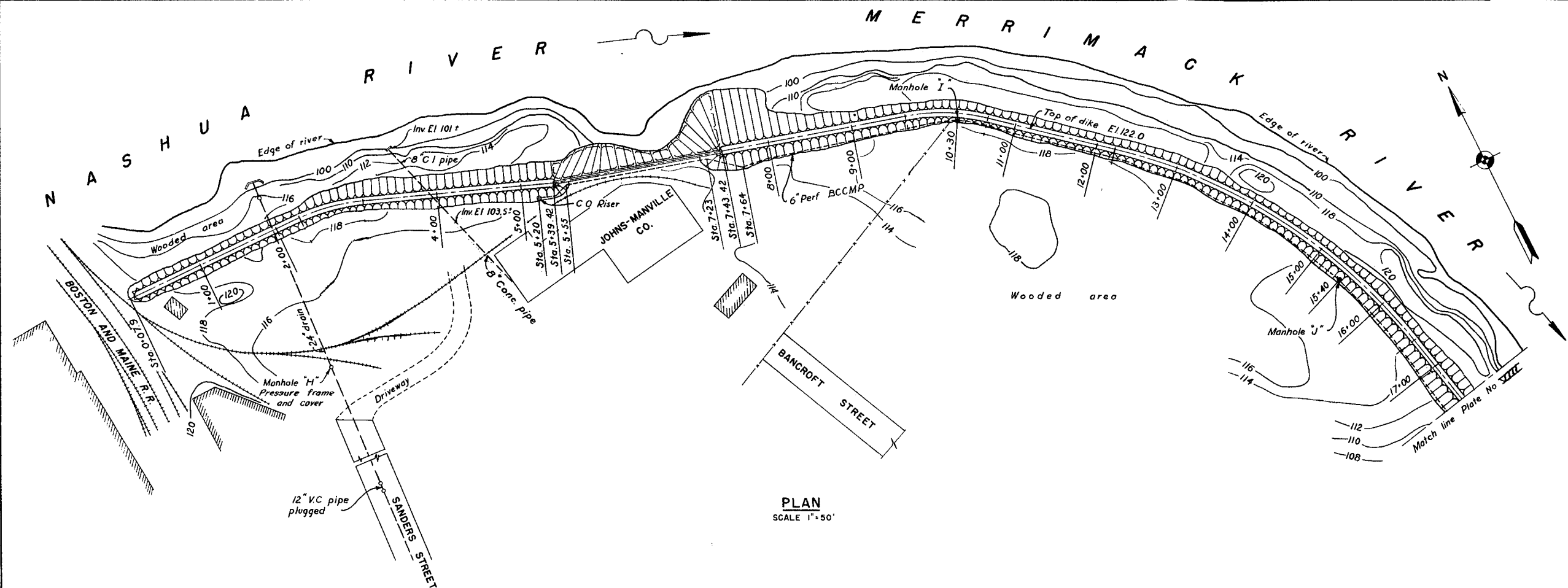
**PREPARED BY**  
**CORPS OF ENGINEERS, U.S. ARMY**  
**OFFICE OF THE DIVISION ENGINEER**  
**NEW ENGLAND DIVISION, BOSTON, MASS.**  
**MARCH 1950**



MERRIMACK VALLEY FLOOD CONTROL  
FLOOD PROTECTIVE WORKS  
NASHUA, N H  
OPERATION AND MAINTENANCE MANUAL  
PROJECT MAP OF LOCAL PROTECTION WORKS

PREPARED BY  
CORPS OF ENGINEERS, U. S. ARMY  
OFFICE OF THE DIVISION ENGINEER  
NEW ENGLAND DIVISION, BOSTON, MASS  
JULY 1949

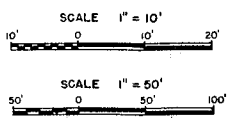




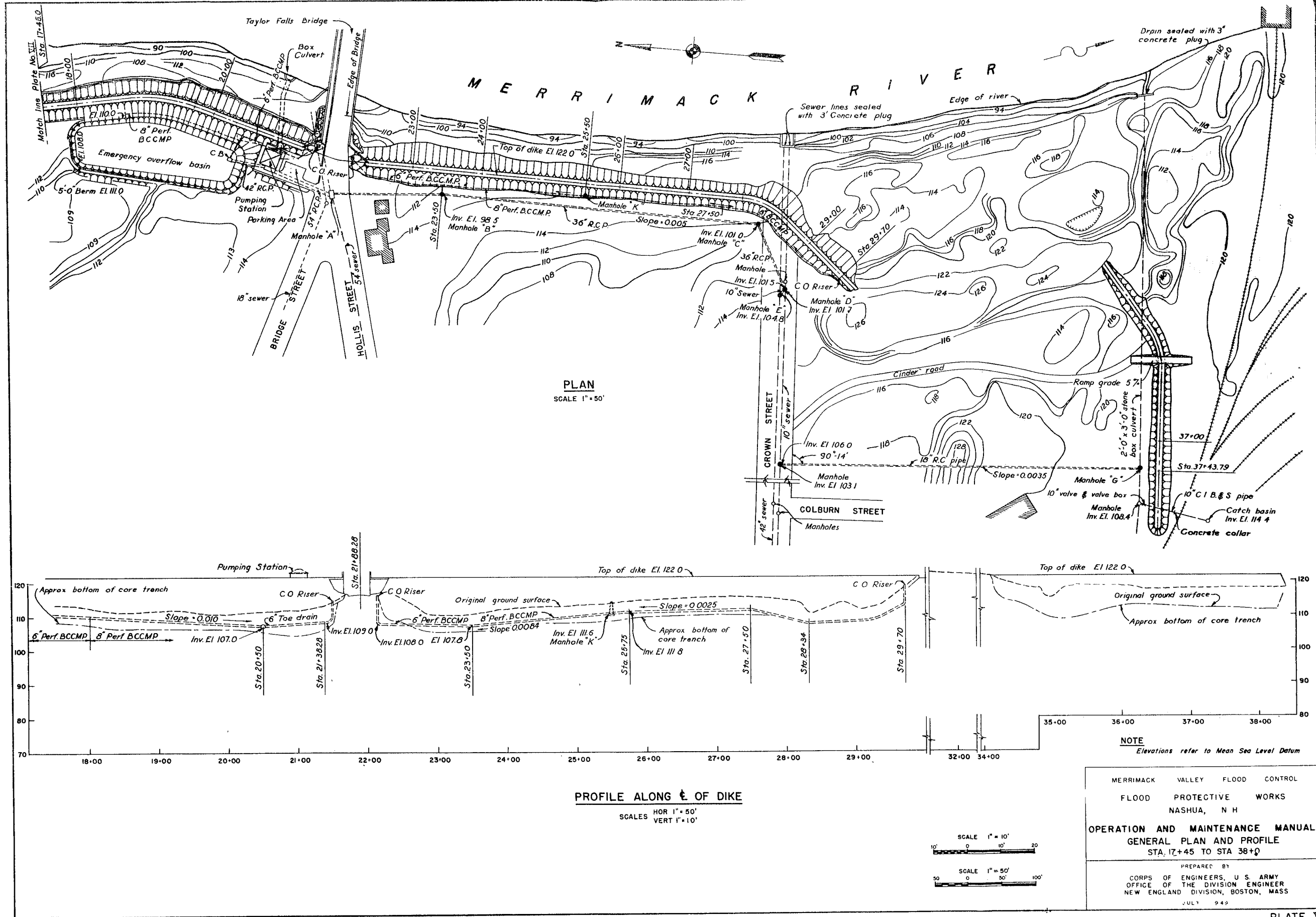
PROFILE ALONG C OF DIKE

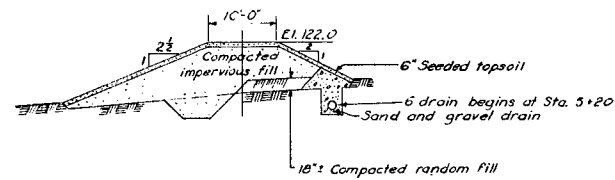
SCALES  
HOR 1" = 50'  
VERT 1" = 10'

NOTE  
Elevations refer to Mean Sea Level Datum

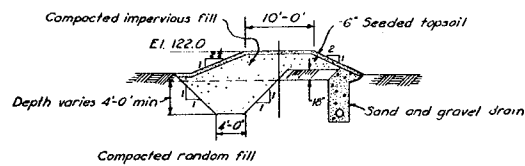


MERRIMACK VALLEY FLOOD CONTROL  
FLOOD PROTECTIVE WORKS  
NASHUA, N. H.  
OPERATION AND MAINTENANCE MANUAL  
GENERAL PLAN AND PROFILE  
STA 0+00 TO STA 17+45  
PREPARED BY  
CORPS OF ENGINEERS, U. S. ARMY  
OFFICE OF THE DIVISION ENGINEER  
NEW ENGLAND DIVISION, BOSTON, MASS  
JULY 1949

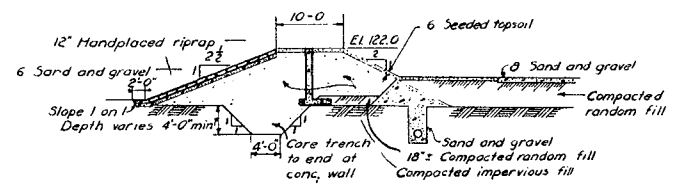




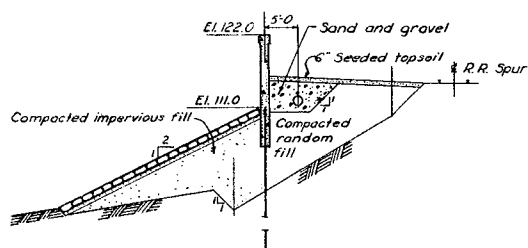
SECTION - STA. 5+20  
SCALE 1" = 10'



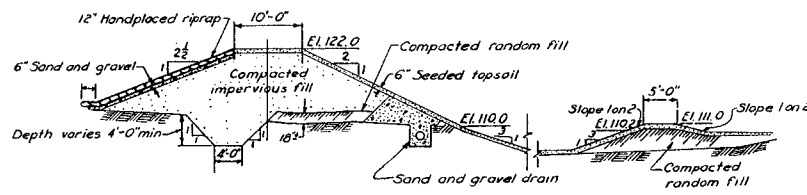
SECTION - STA. 10+50  
SCALE 1" = 10'



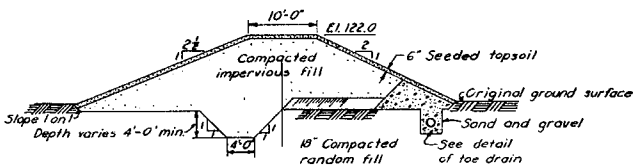
SECTION - STA. 21+38  
SCALE 1" = 10'



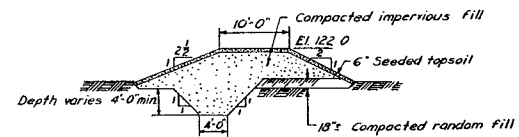
SECTION - STA. 7+00  
SCALE 1" = 10'



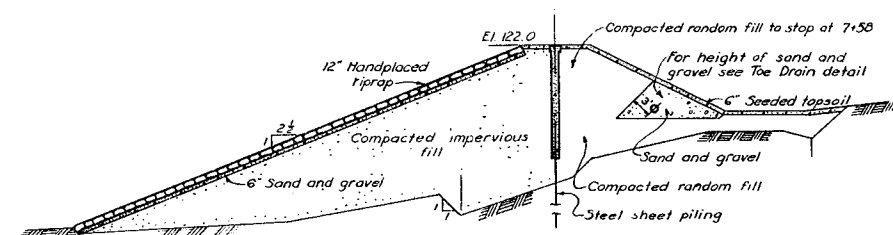
SECTION - STA. 19+50  
SCALE 1" = 10'



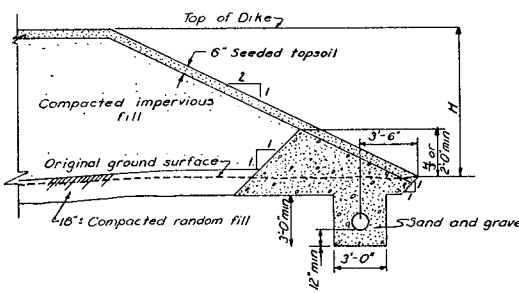
SECTION - STA. 29+00  
SCALE 1" = 10'



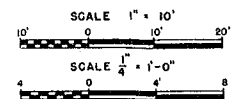
SECTION - STA. 36+70  
SCALE 1" = 10'



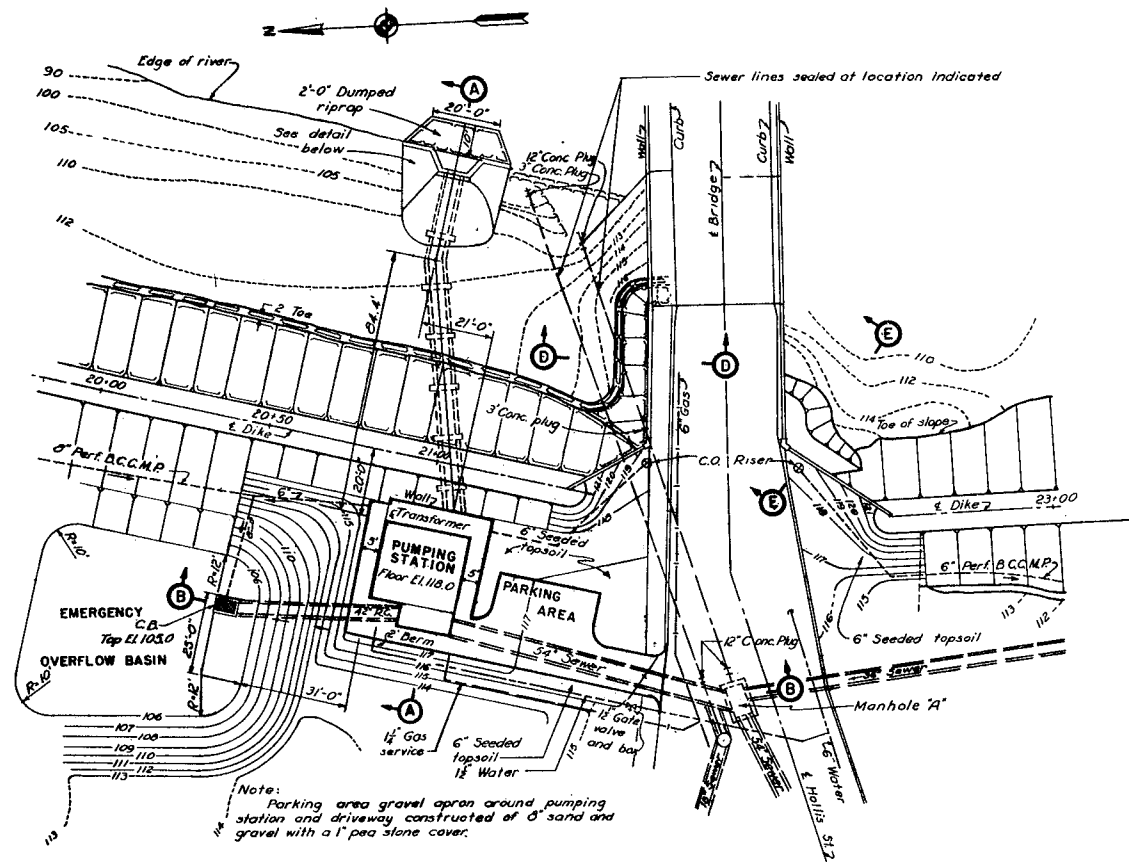
SECTION - STA. 7+43.4  
SCALE 1" = 10'



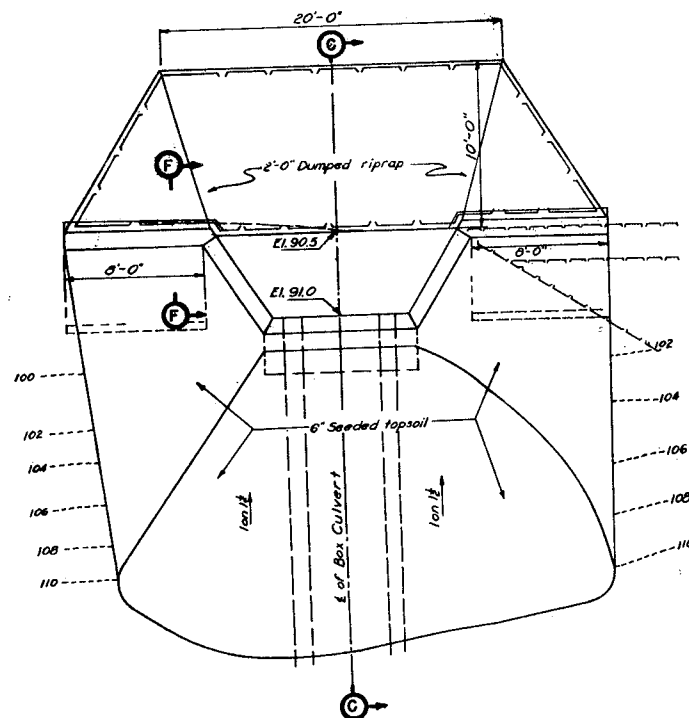
TOE DRAIN DETAIL  
SCALE 1/4" = 1'-0"



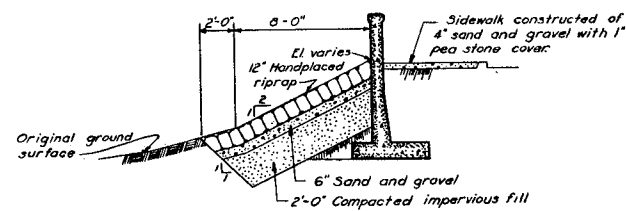
MERRIMACK VALLEY FLOOD CONTROL  
FLOOD PROTECTIVE WORKS  
NASHUA, N. H.  
OPERATION AND MAINTENANCE MANUAL  
TYPICAL DIKE AND FLOOD WALL SECTIONS  
PREPARED BY  
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NEW ENGLAND DIVISION, BOSTON, MASS  
JULY 1949

**PLAN**

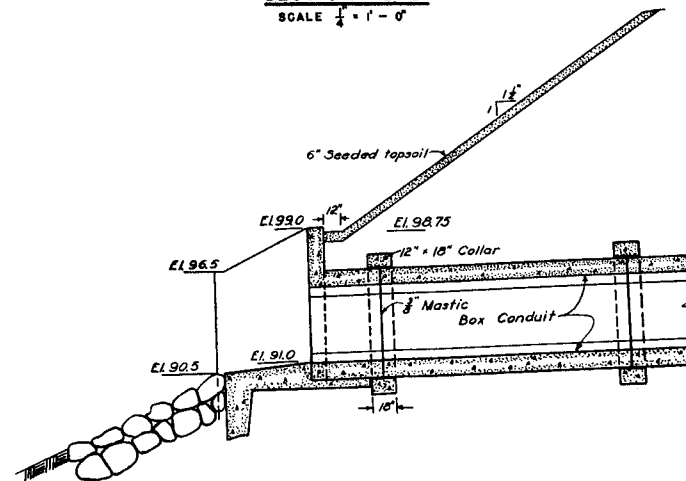
SCALE 1" = 20'-0"

**PLAN OF HEADWALL**

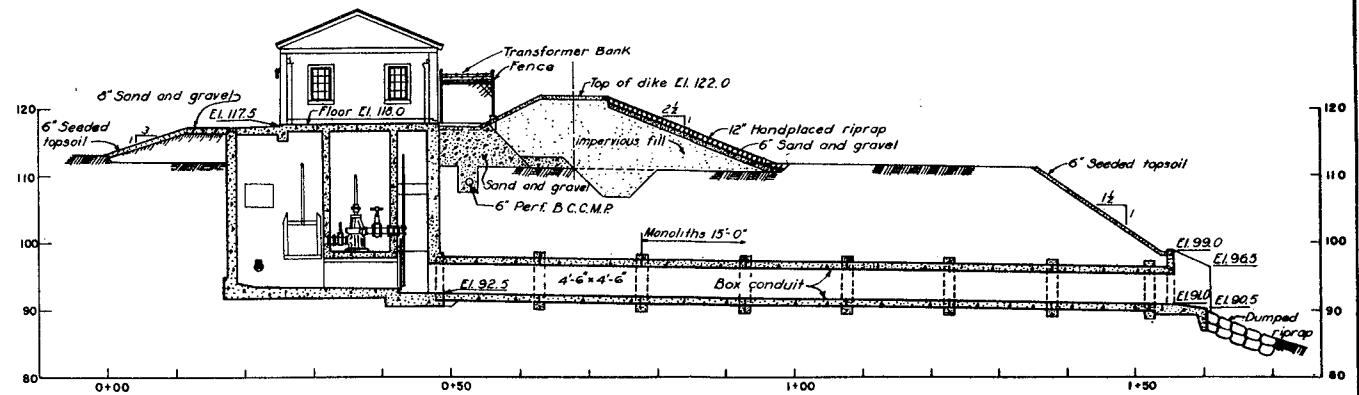
SCALE 1" = 1'-0"

**SECTION D-D**

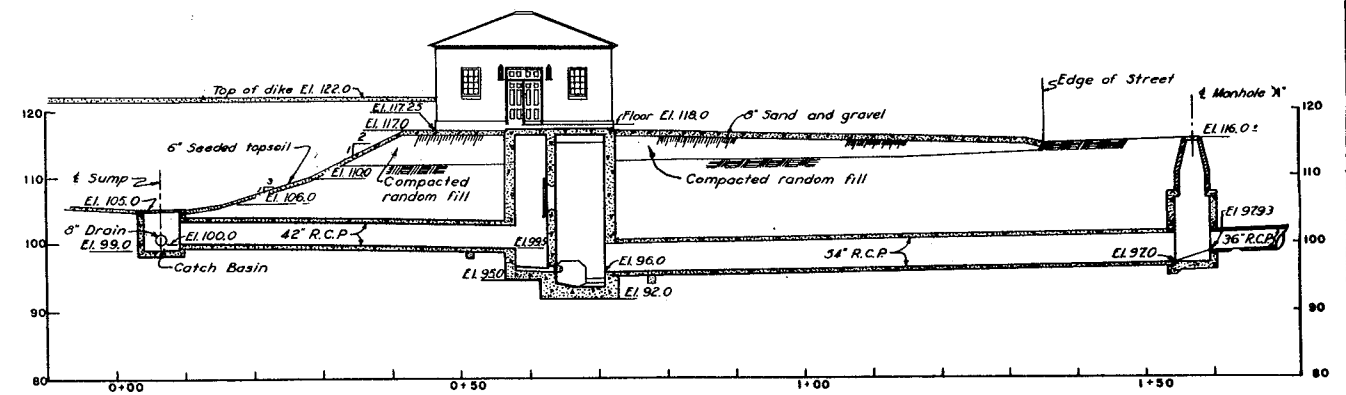
SCALE 1" = 1'-0"

**SECTION C-C**

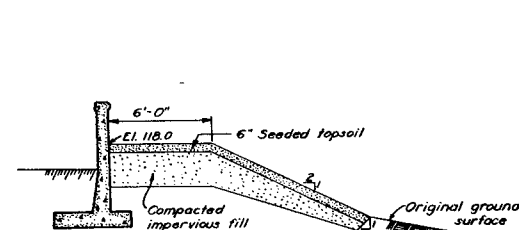
SCALE 1" = 1'-0"

**SECTION A-A**

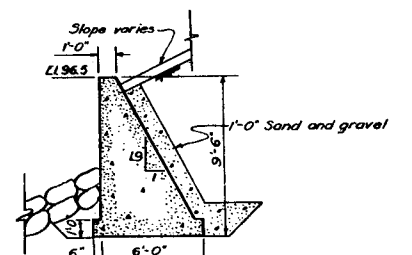
SCALE 1" = 10'-0"

**SECTION B-B**

SCALE 1" = 10'-0"

**SECTION E-E**

SCALE 1" = 1'-0"

**SECTION F-F**

SCALE 1" = 1'-0"

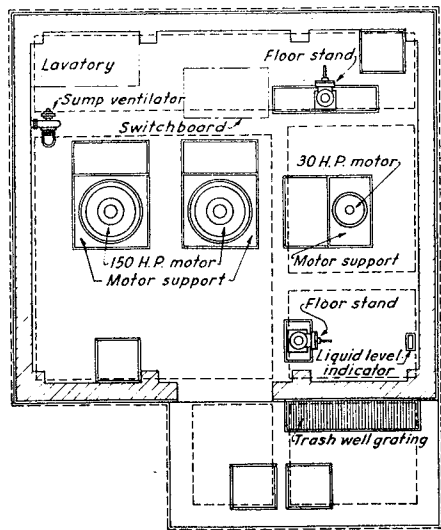
**NOTE**

Elevations refer to Mean Sea Level Datum

MERRIMACK VALLEY FLOOD CONTROL

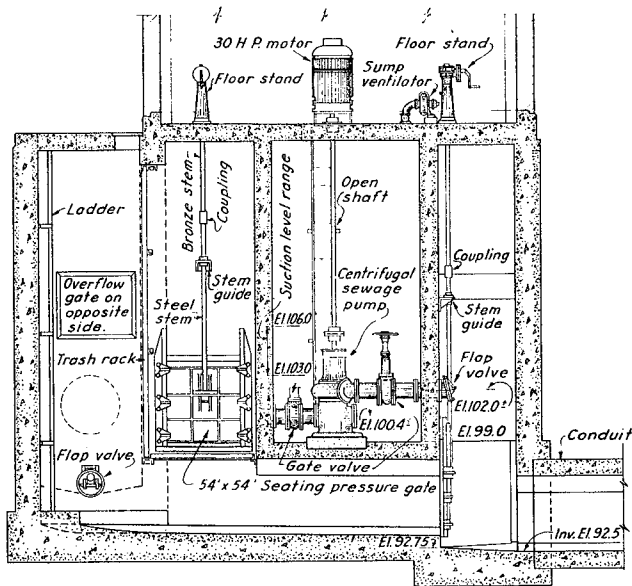
FLOOD PROTECTIVE WORKS  
NASHUA, N HOPERATION AND MAINTENANCE MANUAL  
PUMPING STATION AREA  
PLAN AND SECTIONSPREPARED BY  
CORPS OF ENGINEERS, U. S. ARMY  
OFFICE OF THE DIVISION ENGINEER  
NEW ENGLAND DIVISION, BOSTON, MASS

JULY 1949



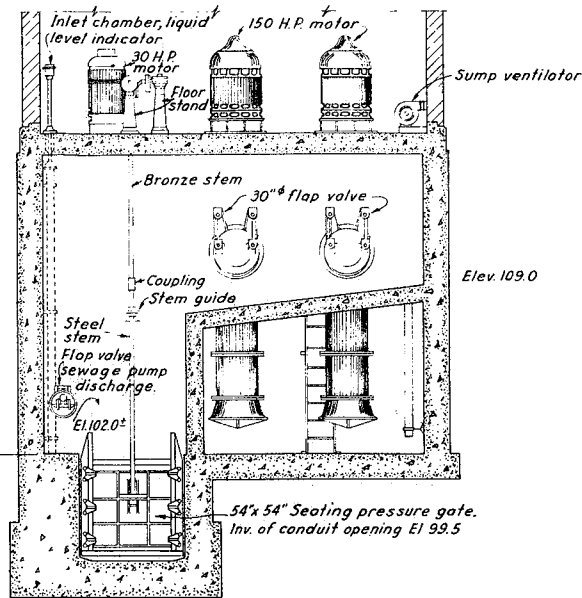
MOTOR ROOM FLOOR

SCALE 1/4" = 1'-0"



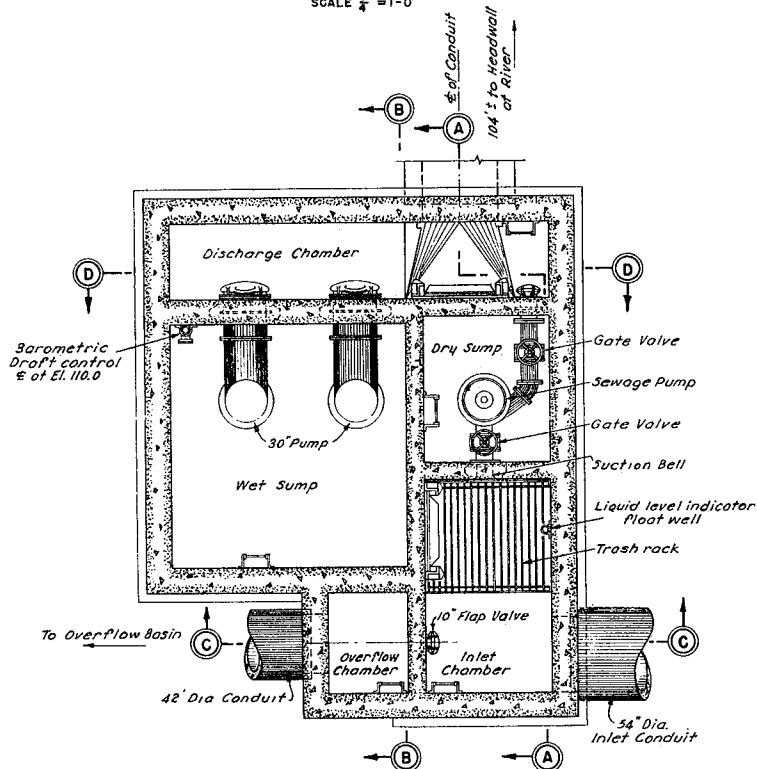
SECTION A-A

SCALE 1/4" = 1'-0"



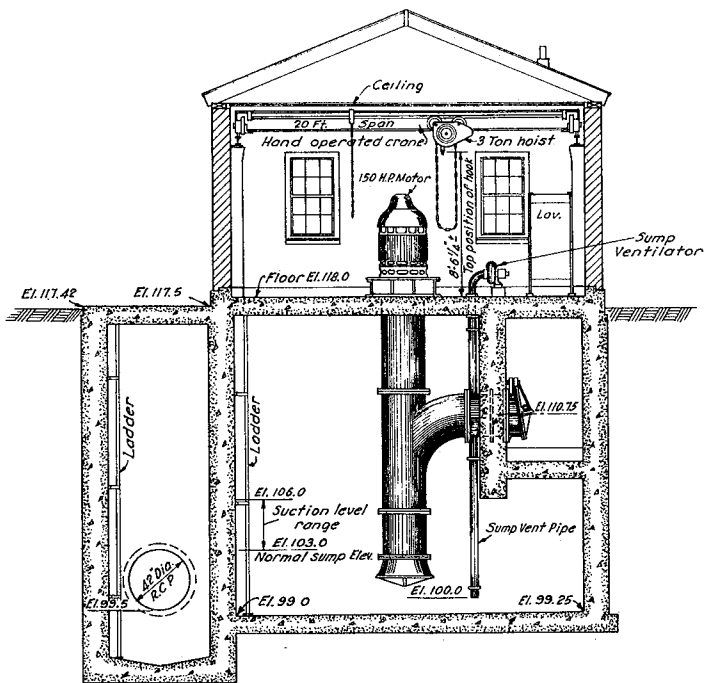
SECTION D-D

SCALE 1/4" = 1'-0"



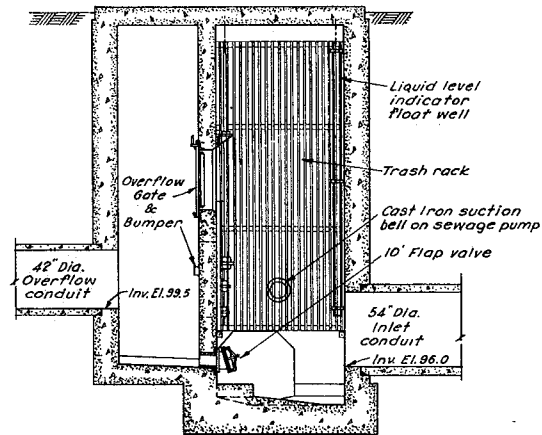
SUMP ROOM PLAN

SCALE 1/4" = 1'-0"



SECTION B-B

SCALE 1/4" = 1'-0"

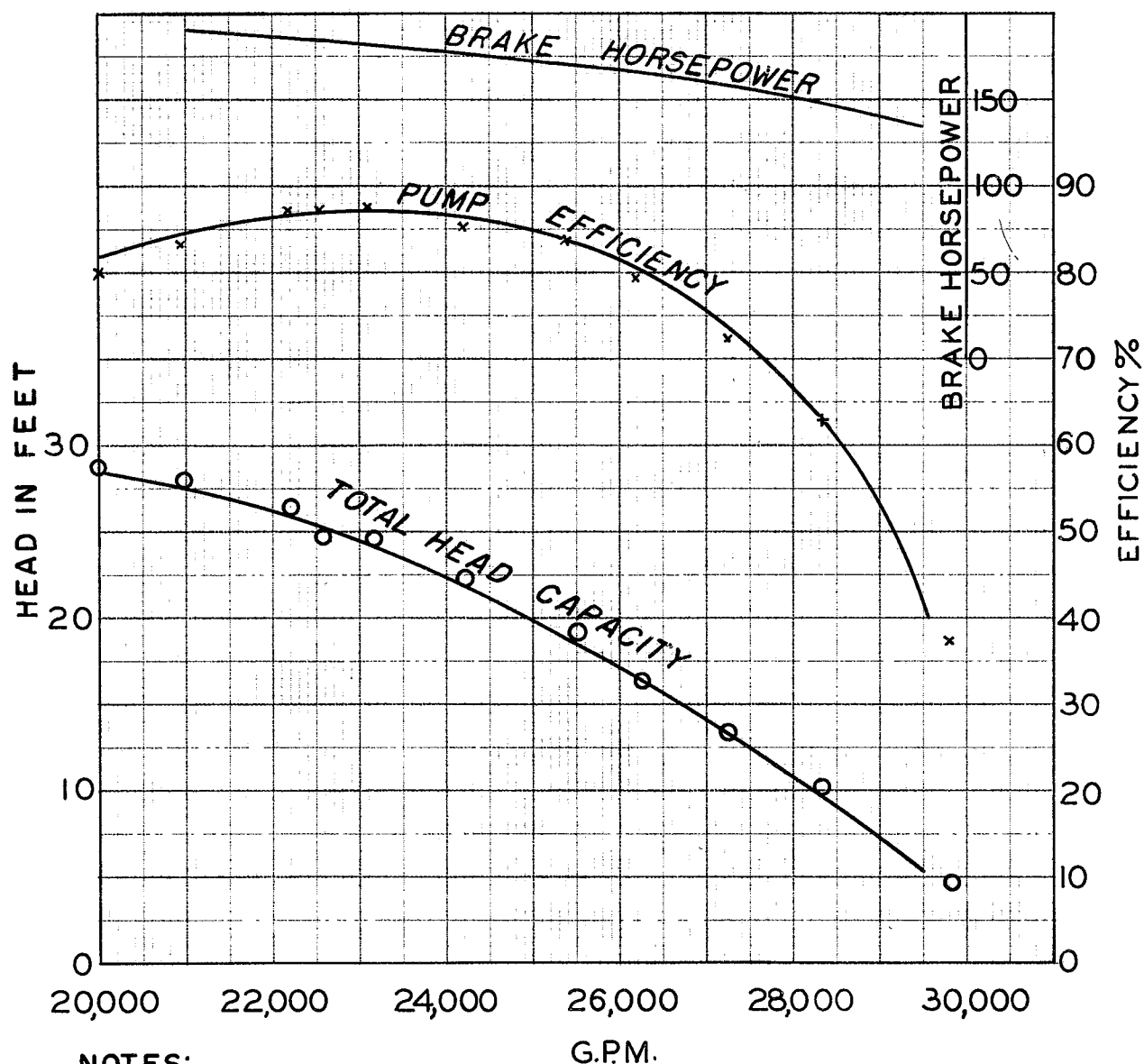


SECTION C-C

SCALE 1/4" = 1'-0"

SCALE 1/4" = 1'-0"

MERRIMACK VALLEY FLOOD CONTROL
FLOOD PROTECTIVE WORKS
NASHUA, N H
OPERATION AND MAINTENANCE MANUAL
PUMPING STATION
ARRANGEMENT OF EQUIPMENT
PREPARED BY
CORPS OF ENGINEERS, U. S. ARMY
OFFICE OF THE DIVISION ENGINEER
NEW ENGLAND DIVISION, BOSTON, MASS
JULY 1949



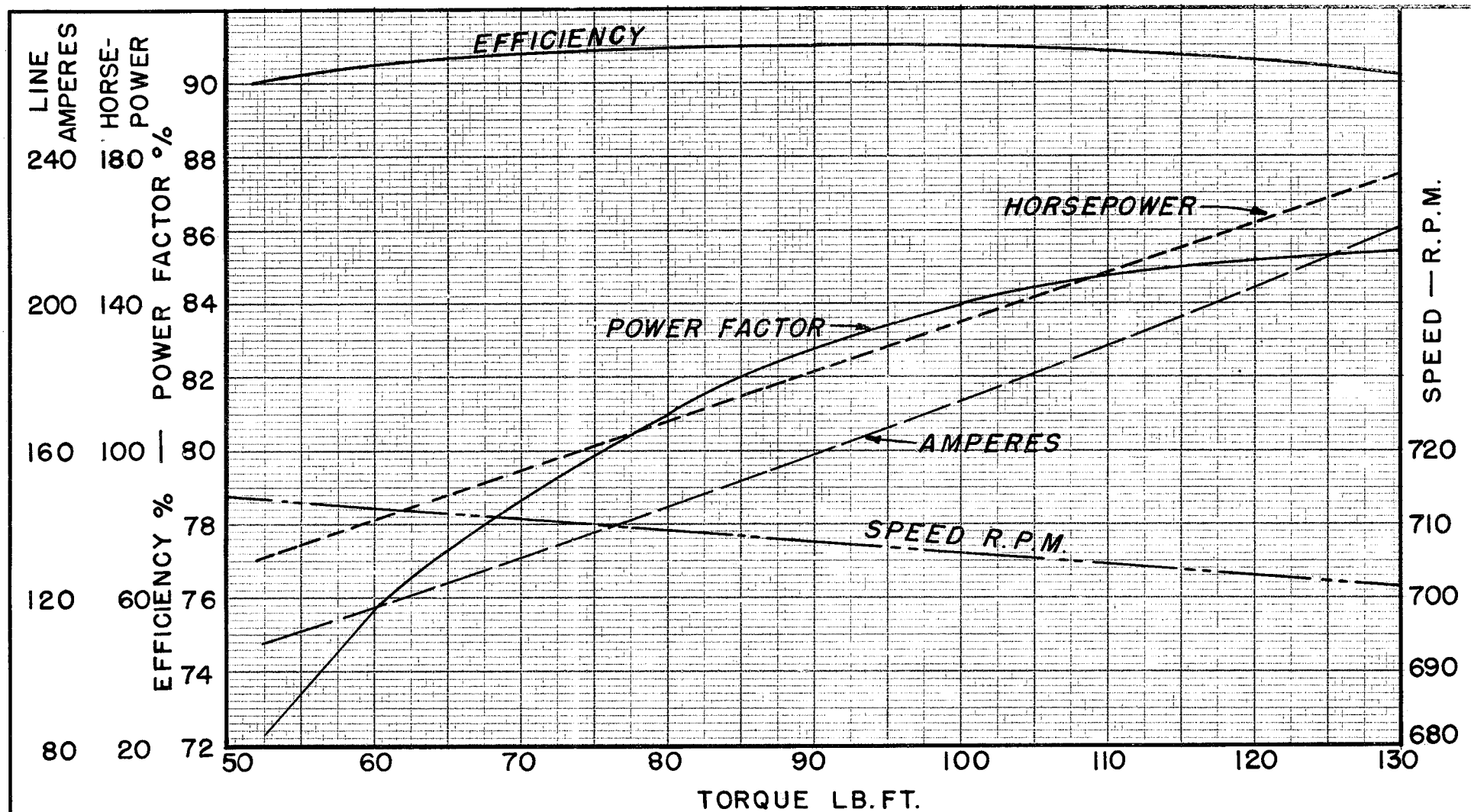
**NOTES;**

All losses in 16 Ft. of 30" O.D. Column, 30" Enclosed Discharge Elbow & 30" Flap Valve are charged against pump.

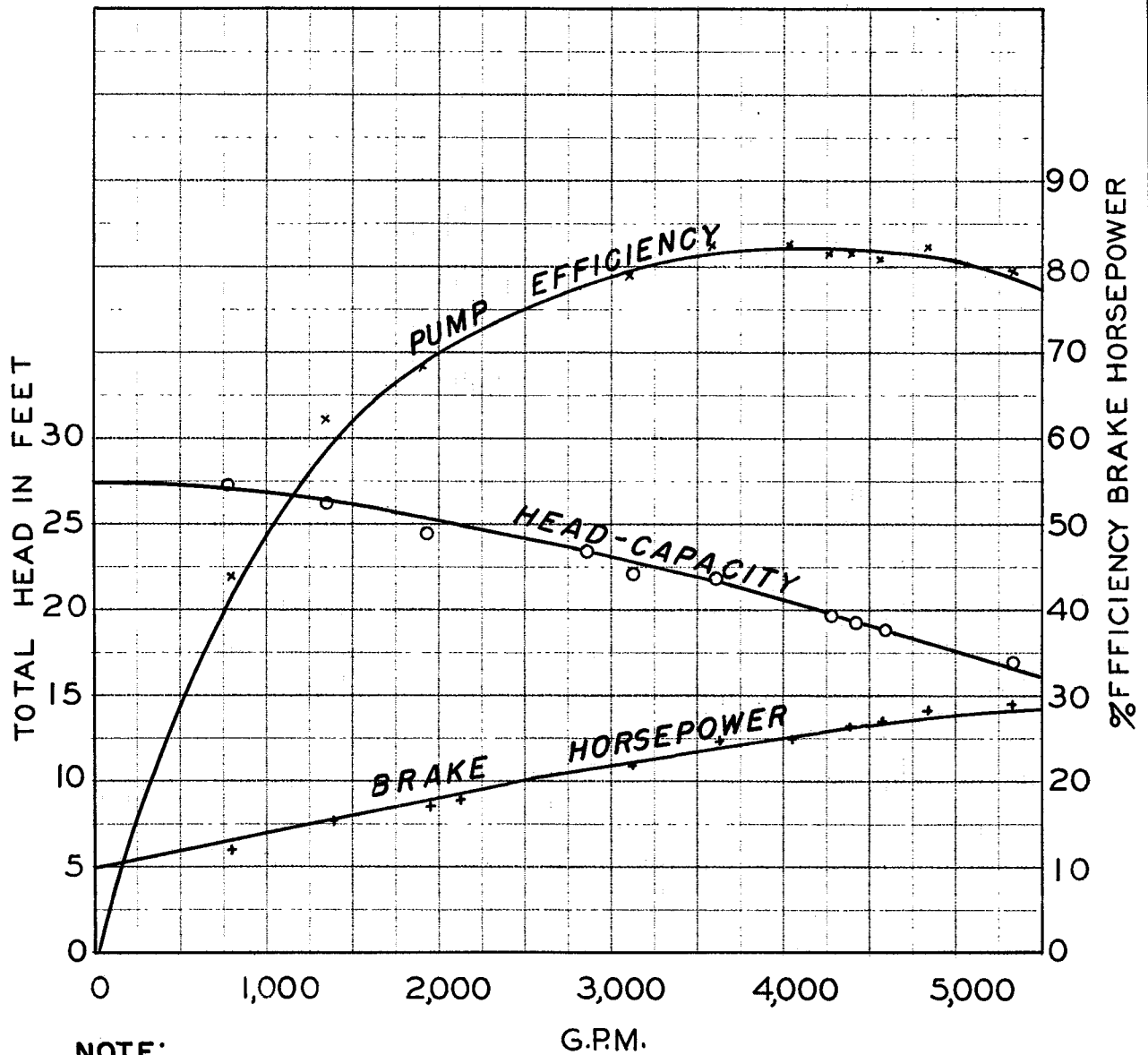
Brake horsepower drawn from field data is approx. only.

Performance of 30" Fig. 6310 Propeller Pump with propeller A-134. A-3-1/2 at 700 R.P.M.

MERRIMACK RIVER FLOOD CONTROL  
NASHUA PUMPING STATION  
CHARACTERISTIC CURVES  
30" PROPELLER PUMP  
NEW ENGLAND DIVISION BOSTON, MASS.  
FEBRUARY 1950



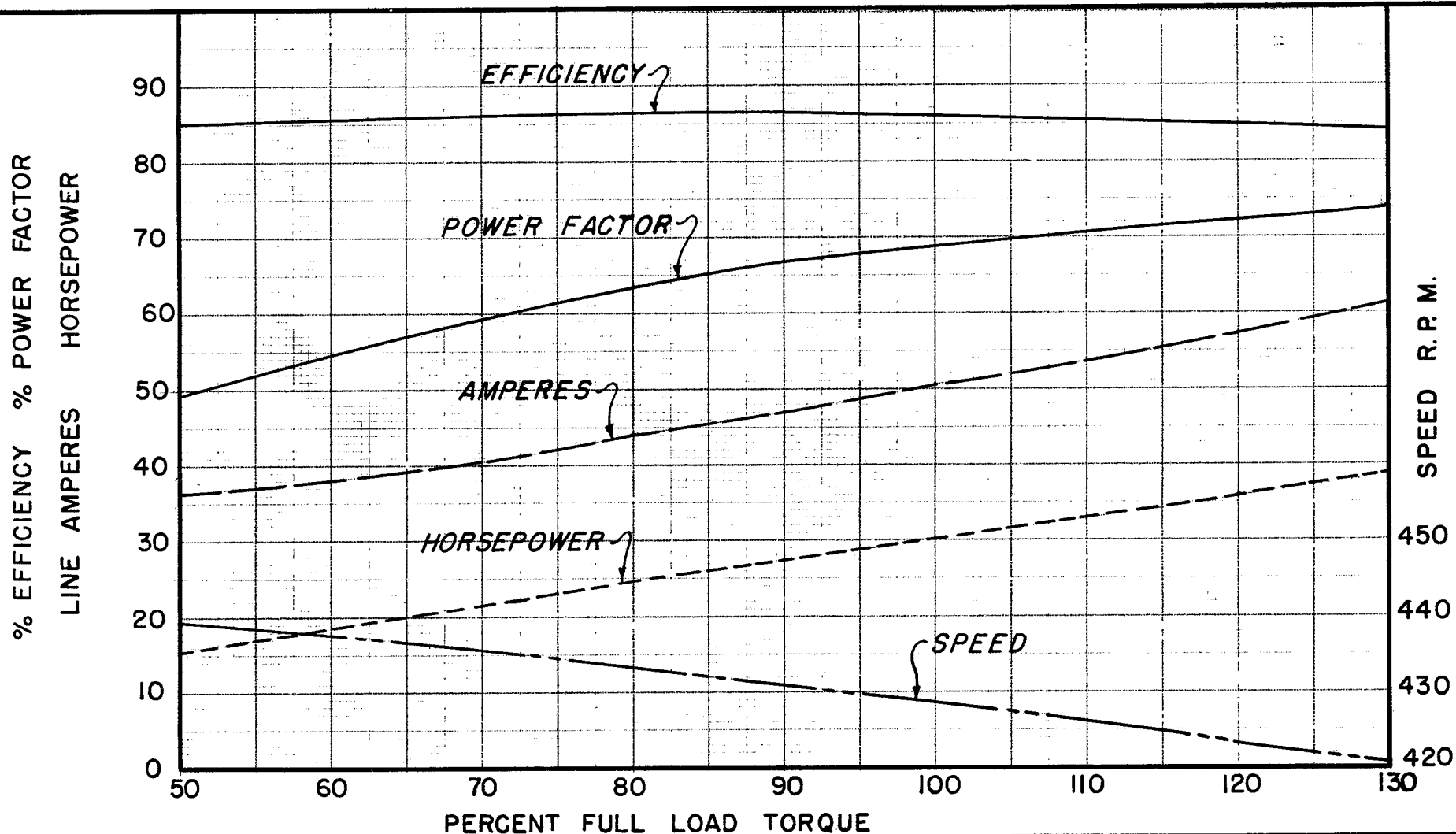
MERRIMACK RIVER FLOOD CONTROL  
 NASHUA PUMPING STATION  
 PERFORMANCE CURVES  
 150 H.P. MOTOR  
 NEW ENGLAND DIVISION BOSTON, MASS.  
 FEBRUARY 1950



**NOTE:**

Test #3684-A-6/8/48.  
 10x12x14 N.C. PUMP  
 20 Dia. Impeller-30144  
 435 R.P.M.  
 Pump No. E-6508

MERRMACK RIVER FLOOD CONTROL  
 NASHUA PUMPING STATION  
 CHARACTERISTIC CURVES  
 12" VOLUTE PUMP  
 NEW ENGLAND DIVISION BOSTON, MASS.  
 FEBRUARY 1950



MERRIMACK RIVER FLOOD CONTROL  
NASHUA PUMPING STATION  
PERFORMANCE CURVES  
30 H.P. MOTOR  
NEW ENGLAND DIVISION BOSTON, MASS.  
FEBRUARY 1950

INSULATION RESISTANCE IN MEGOHMS

1000  
100  
10  
1.0  
.9  
.8  
.7  
.6  
.5  
.4  
.3  
.2

10

20

30

TEMPERATURE

DEGREES CENTIGRADE

40

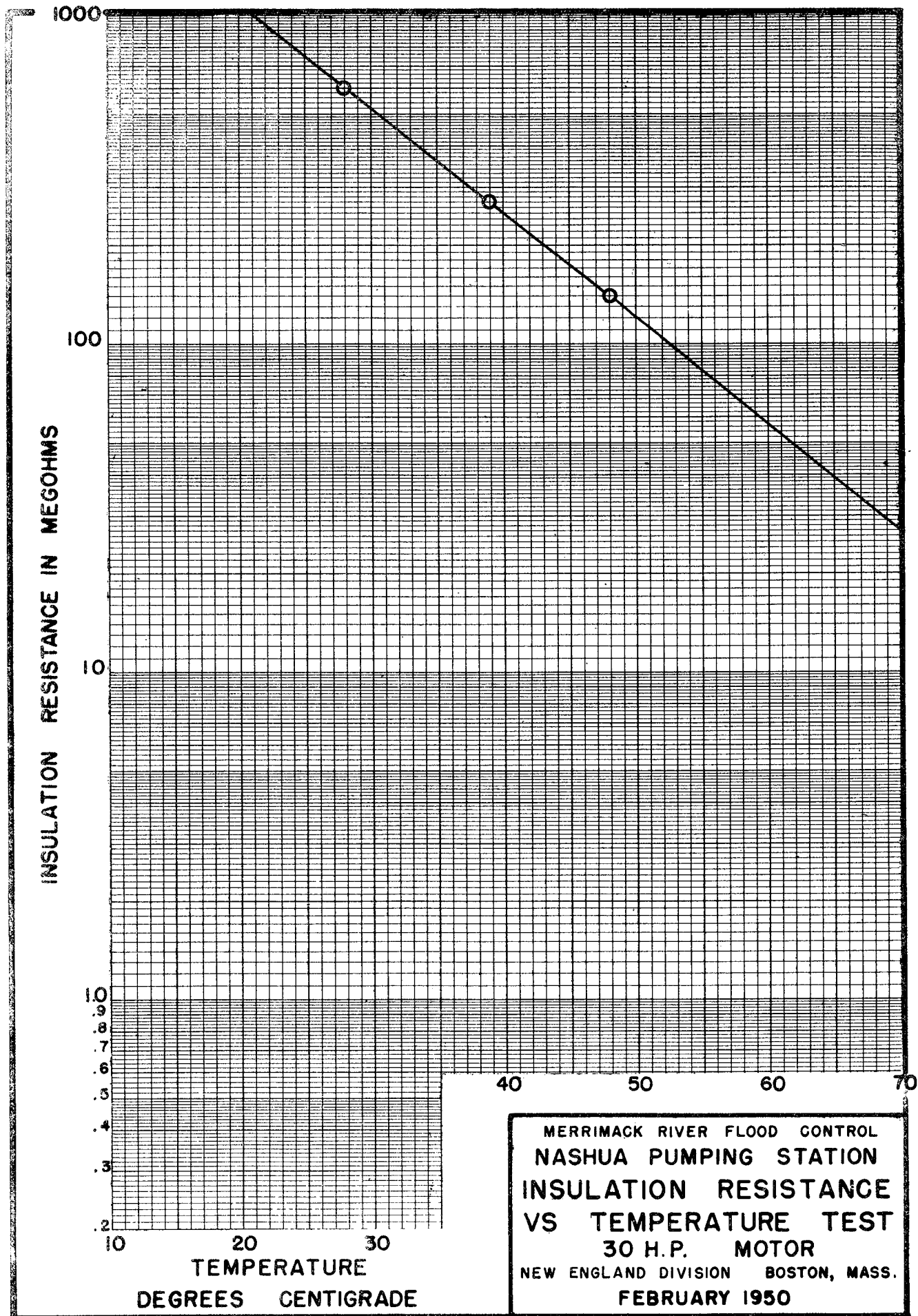
50

60

70

MERRIMACK RIVER FLOOD CONTROL  
NASHUA PUMPING STATION  
INSULATION RESISTANCE  
VS TEMPERATURE TEST  
150 H.P. MOTOR  
NEW ENGLAND DIVISION BOSTON, MASS.  
FEBRUARY 1950

PLATE NO. XVI



INSULATION RESISTANCE AT 60°C IN MEGOHMS

140  
120  
100  
80  
60  
40  
20  
0

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

NUMBER OF TEST

NOTE

*Indicate date of test.*

MERRIMACK RIVER FLOOD CONTROL  
NASHUA PUMPING STATION  
INSULATION RESISTANCE  
VS TIME RECORD

NEW ENGLAND DIVISION BOSTON, MASS.  
FEBRUARY 1950

PLATE NO. XVIII